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AND

MAGAZINE OF NATURAL HISTORY,

INCLUDING

ZOOLOGY, BOTANY, AND GEOLOGY.

(BEING A CONTINUATION OF THE 'ANNALS' COMBINED WITH LOUDON AND CHARLESWORTH'S 'MAGAZINE OF NATURAL HISTORY.')

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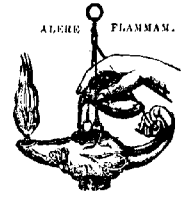
"Omnes res creatæ sunt divinæ sapientiæ et potentiæ testes, divitiæ felicitatis humanæ:—ex harum usu *bonitas* Creatoris; ex pulchritudine *sapientia* Domini; ex œconomiâ in conservatione, proportione, renovatione, *potentia* majestatis elucet. Earum itaque indagatio ab hominibus sibi relictis semper æstimata; à verè eruditis et sapientibus semper exculta; malè doctis et barbaris semper inimica fuit."—LINNÆUS.

"Quel que soit le principe de la vie animale, il ne faut qu'ouvrir les yeux pour voir qu'elle est le chef-d'œuvre de la Toute-puissance, et le but auquel se rapportent toutes ses opérations."—BRUCKNER, *Théorie du Système Animal*, Leyden, 1767.

. . . . . The sylvan powers
Obey our summons; from their deepest dells
The Dryads come, and throw their garlands wild
And odorous branches at our feet; the Nymphs
That press with nimble step the mountain-thyme
And purple heath-flower come not empty-handed,
But scatter round ten thousand forms minute
Of velvet moss or lichen, torn from rock
Or rifted oak or cavern deep: the Naiads too
Quit their loved native stream, from whose smooth face
They crop the lily, and each sedge and rush
That drinks the rippling tide: the frozen poles,
Where peril waits the bold adventurer's tread,
The burning sands of Borneo and Cayenne,
All, all to us unlock their secret stores
And pay their cheerful tribute.

J. TAYLOR, *Norwich*, 1818.



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THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[NINTH SERIES.]

"..... per litora spargite muscum,
Naiades, et circum vitreos considite fontes;
Pollice virgineo teneros hic carpite flores:
Floribus et pictum, divæ, replete canistrum.
At vos, o Nymphæ Crateridες, ite sub undas;
Ite, recurvato variata corallia trunco
Vellite muscosis e rupibus, et mihi conchas
Ferte, Deæ pelagi, et pingui conchylia succo."
N. Parthenii Giannettasi, Ecl. I.

No. 7. JULY 1918.

I.—*Notes from the Gatty Marine Laboratory, St. Andrews.* —No. XLI. By Prof. M'Intosh, M.D., LL.D., D.Sc., F.R.S., &c.

[Plates I.–VI.]

1. On some Points in the Structure of the *Sabellidæ*, chiefly of *Bispira volutacornis*, Montagu.
2. On some Points in the Structure of the *Serpulidæ*, chiefly of *Pomatoceros triqueter*, L.

1. *On some Points in the Structure of the* Sabellidæ, *chiefly of* Bispira volutacornis, Montagu.

Many authors have alluded to the structure of the Sabellids since Cuvier noted that they rarely form a calcareous tube, whilst they had the fan-like gills and the thoracic membrane of the Serpulids. In alluding to the branchiæ of the Sabellids he mentions "un filament charnu," and, further, that in this group the two "filets charnus" (fleshy filaments —probably the tentacles) adherent to the branchiæ do not form an operculum. Most text-books, like those of Huxley, Gegenbaur, and Hayek, contain references to the "cartilaginous" skeleton in Sabellids and Serpulids.

Amongst others, R. Wagener* (1832) describes the alimentary canal in *Sabella ventilabrum* (*S. penicillus*, L.) as having two sacs in front, such apparently, from his figure, representing the anterior nephridia. He pointed out the commissures connecting the great nerve-cords.

Milne-Edwards (1838) considered the circulation in the Sabellids to be akin to that of *Nephthys* and the Nereidæ, a dorsal and a ventral trunk being present, and the inner aspect of the integument is supplied with a multitude of vascular filaments for the secretory organs, and, with the bases of the feet, present also a capillary *rete* which probably aids in respiration, though the main respiratory organs are the cephalic fans. He did not allude to the special vascular sinus around the gut.

Grube (1838) gave a general account of the structure of *Sabella unispira* (*Spirographis spallanzani*), especially of the alimentary and circulatory systems. He pointed out that Leuckart was wrong in attributing two vascular trunks to each branchial filament. He thought that the anterior (thoracic) nephridia were connected with reproduction.

Kölliker†, in his researches (1856), describes the "cartilage" of several annelids, such as *Sabella unispira* (*Spirographis spallanzani*), but he was uncertain as to the distinctions between the blood-vessels and the nerves of the filaments, and his figures indicate that his "Knorpelfaden" structurally differs from that described here. He noted the specially thickened hypoderm (his epithelial layer).

De Quatrefages (1850) thought that in the branchiæ of the Sabellidæ and Serpulidæ are venous and arterial twigs, which mingle in a system of vessels the walls of which cannot be distinguished from the surrounding tissues, and in which respiration is carried on through the thin covering tissues and their cilia. He describes in these branchiæ what he terms a cartilaginous skeleton, composed of cells surrounded by a tough fibrous investment like a periosteum. According to this author, the cephalic ganglia in *Sabella flabellata*, Savigny, form two pairs connected by a large commissure, and from these branches go to the branchiæ and the eyes. The œsophageal connectives are very short. The visceral system seems to arise from these ganglia as a small twig on each side furnished with two ganglia. The great ventral nerve-cords are separate throughout, though nearer each other posteriorly, and the first ganglia are close to the cephalic,

* 'Isis,' 1832, p. 655, Taf. x.

† 'Untersuchungen z. vergl. Gewebelehre angestelt in Nizza im Herbste' (1 Sitzung, 13 Dec.).

the others following segmentally, each being joined to its neighbour by fine connectives and giving branches to the muscles and various organs.

Dr. Thos. Williams* (1858) stated that the segmental organs both in Sabellids and Serpulids were absent from the anterior or thoracic region and were present only in the abdominal portion in the form of looped tubes, but he could not distinguish the part of the tube to which the ova were attached. He thought the ova did not escape into the cœlom, but were confined in a membranous bag. He found a similar structure in the Amphictenidæ, Spionidæ, and other forms.

In *Spirographis spallanzani* Claparède (1873) describes the giant fibres of the nerve-cords as separate in the interganglionic spaces from the trunk, and figures them (his pl. v. fig. 5) surrounded by connective tissue. Internally is a medullary substance. These fibres run throughout the abdomen without apparent anatomical connection. In the thorax they are repeatedly joined by anastomoses. Throughout the rest of the body the nervous chain is united in each segment by two transverse commissures. On entering the thorax the two tubular fibres divide into two branches, which pass forward reduced in diameter, and ultimately penetrate the cerebral ganglia, where they branch and are lost. Various branches are given off from the tubular fibres along the commissures, but he could not trace them along the ventral nerves of the thorax. The branchial nerves are greatly developed in the Sabellids and in *Myxicola*. He found in *Spirographis* that circular muscular fibres penetrate the ventral shields and that the fibres generally show nuclei surrounded by granular matter. Further, that in transverse section of the setigerous processes the bristles are arranged in a spiral, just as Pruvot and Racovitza showed subsequently. No dorsal vessel exists anteriorly, only a plexus of anastomosing trunks from which the large branchial vessel arises on each side. A periintestinal sinus surrounds the stomach †. There is a well-developed rete in the collar, and the purified blood afterwards enters the ventral trunk.

He considered that in the Sabellids the connective tissue of the anterior region is of importance and aids in filling up the cœlomic cavity, which is almost suppressed, except the spaces for the branchial vessels. The two segmental tubes

* Philos. Trans. 1858, p. 123, pl. vii. fig. 13.

† De Quatrefages first described this plexus around the gut (his lacunar system).

in front are curved on themselves, and are highly vascular. He thought they secreted mucus.

He describes and figures the "cartilage" of the branchial apparatus of *Spirographis*, with its "perichondrium," as if this was a separate tissue, and the same tissues occur in *Myxicola* and *Protula*. In his figure this structure is shown as a rod with a single transverse series of septa in the filaments, and his description of the general structure corresponds with that in *Bispira*. His figures of the various parts in the sections of *Spirographis*, though small, are generally true to nature, for the author had equal facility with pen and pencil.

Löwe * (1878–9) distinguishes in the branchiæ of the Serpulids an ectothelium and an endothelium, the former coating the outer surface of the bifid region in a section of the filament, the latter the inner surface. He seems to agree with Kowalewsky in regard to the homologies of the nervous system of worms and vertebrates, and concludes with a comparison of the Sabellid skeleton with that of the embryo dog's skull in horizontal section (his fig. 8).

Cosmovici (1880) considered that, as in *Myxicola*, the organ of Bojanus in the Sabellids was situated at the anterior end, each organ, from a pouch which is longer than in *Myxicola*, opening by a pore, the cilia of the interior causing currents in this direction. The segmental organs are found, he states, in each segment from the middle of the body to the tail, and consist of a ciliated funnel behind the diaphragm and a tube which opens below the setigerous process of the foot. These organs transmit the reproductive elements, which are developed in glands attached to the inferior lateral vessel and extending to the superior lateral vessel. He thus considered the thoracic glands the organs of Bojanus.

A careful account of the thoracic glands and other segmental organs is given by Prof. Haswell † (1884), who, in contrast with the views of some later authors, could find no internal opening of the former. His sections of the thoracic region of *Eupomatus*, a Serpulid, agree on the whole with those of *Pomatocerus*. He points out that the true segmental organs are found in pairs in all the segments of the posterior or abdominal region. He figures the appendix to the thoracic glands in *Eupomatus*, but does not allude to it. The position of the nerve-cords in relation to the ventral longitudinal

* Zeitsch. f. w. Zool. Bd. xxxii. p. 158, Taf. ix.

† Proc. Linn. Soc. N.S.W. vol. ix. pp. 7–12 (sep. copy).

muscles needs revision, but the general structure is in accordance with nature. His account of the circulation in both Sabellids and Serpulids is excellent.

Viallanes * (1885) thought the skeletogenous tissue of the Sabellids (e. g., *Sabella flabellata*) approached that of the vertebrates, though Krukenberg found that chemically it differed. In the tentacles (his antennæ) the skeleton ("tige cartilagineuse") forms a central arc enveloped in thick perichondrium continued from the branchial lamina, and it seems to be absolutely homogeneous and transparent, though composed of a single row of cells. The perichondrium he compares to horn, and it and the "cartilage" have no ground- or fundamental substance. This skeleton is in contact with a blood-vessel which passes to the tip and is surrounded by a lymphatic space, and he thought that the lymph, and not the blood, respired directly.

Pruvot † (1885), like many others, alluded to the branchial "cartilage" of the Sabellids, and described the union of the dorsal and ventral longitudinal muscles to form two large cylindrical muscles which go to the branchiæ, a fasciculus passing to each filament. The anterior thoracic glands are coiled or tangled ("enchevêtrés"), and open dorsally behind the branchiæ in the median line. He did not place the same weight as Claparède did on the distinctions of this organ in the Sabellids and Serpulids respectively, and they are soldered in the middle line in *Sabella penicillus*. The tentacles (his antennæ) vary from the normal two to ten or twelve (*Sabella terebelloides, S. analis*, &c.). In *Apomatus ampulliferus*, Phil., there are three pairs, and they resemble the branchial barbules, whilst in *Potamilla reniformis* two pairs occur, the first being well differentiated, but the second represents an intermediate structure with the branchial barbules.

Andrews ‡ (1891) described the structure of the compound eyes of annelids, his *Potamilla reniformis* having seven or eight eyes on each branchial filament instead of the three given by Malmgren; and *Sabella microphthalma*, Verrill, has them on the outer side of each branchial stem, which likewise has transverse bars of pigment. In *Dasychone conspersa*, Ehlers, the eyes also occur along the outer bases of

* Ann. Sc. Nat. 6 sér. t. xx. pp. 1-20, 1 pl.
† Archiv. Zool. Expér. 2 sér. t. iii. p. 335.
‡ Journ. Morphol. pp. 271-399, pl. xxi.

the filaments (pl. xxi. figs. 20–22); and, lastly, he gives an account of *Sabella melanostigma* (pl. xxi. figs. 17–19).

A large memoir on the structure of the Tubicolar Polychæts (chiefly Sabellids and Serpulids) was published by Soulier * (1891). It deals particularly with such forms as *Spirographis spallanzani*, Viviani, *Branchiomma vesiculosum*, Montagu, *Sabella viola*, Grube, *Myxicola infundibulum*, Montagu, and *M. æsthetica*, Claparède; whilst amongst Serpulids *Protula milhaci*, Marion, *Serpula infundibulum*, D. Chiaje, and *Hydroides pectinata*, Müller, were specially studied. Interesting accounts are given of some of these in captivity, including the formation and structure of their tubes and other features. His interpretation of the structure of the anterior "nephridia" (periœsophageal glands) for the most part agrees with that of Ed. Meyer. The histology of the skin and other organs is described with great detail in this paper.

A memoir by Ed. Meyer † on the Sabellidæ and Serpulidæ (his Serpulidea) was published in Russian in 1893. A careful account of the nephridia in *Eupomatus* and *Psygmobranchus* and the structure of the body-wall is given, along with the structure of the nephridia in *Sabellaria alveolata*. Late stages in the development of *Psygmobranchus protensus* further elucidate the subject. Like Soulier, he describes and figures a ciliated funnel opening into the perivisceral cavity at the cephalic end of the anterior segmental organs or thoracic glands. Since the work of Claparède no investigator except Eisig has more fully dealt with the structure of the Polychæts, more especially of the Sabellids and Serpulids, and his memoirs in the Naples 'Mittheilungen' ‡ are models of patient research, skilful draughtsmanship, and general accuracy.

Otocysts were early described in the Sabellids by De Quatrefages (1844) in an *Amphicora*, and, amongst others, Claparède, Langerhans, Meyer, Brunotte, De St. Joseph, Caullery and Mesnil, Soulier, and Fauvel have studied their occurrence in this group. The most comprehensive account is given by Fauvel § (1909), who describes them in *Branchiomma vesiculosum*, in the first bristled segment, in two species of *Potamilla*, viz. *Potamilla reni-*

* Thése, 'Etud. sur l'Anat. des Annél. Tubic. de la Cette, Secret. du Tube, &c.,' Montpellier, 1891.

† 'Die Organisation de Serpuliden u. Hermelliden,' Kasan, 1893, 3 pls.

‡ *E. g.*, Bd. vii. and Bd. viii.

§ Ann. Sc. Nat. 9 sér. t. vi. pp. 1–144, pls. i.–iii.

formis and *P. forelli*, in *Amphiglena mediterranea*, three species of *Jasmineira*, viz. *J. caudata*, *J. oculata*, and *J. elegans*, in *Myxicola infundibulum* and three other species of *Myxicola*, in three species of *Chone*, viz. *C. duneri*, *C. arenicola*, and *C. collaris*, in *Euchone rosea*, *Dialychone acustica*, in *Oria armandi*, and *Orcopsis metchnikowii*. In this family they occupy the first bristled segment and they are innervated from the œsophageal collar. As in other annelids, Fauvel considers that these organs perform the function of statocysts, for perceiving vibrations, and are, perhaps, also organs of orientation.

Numerous instances of the regeneration of both extremities have been recorded in the Sabellids. Thus, Dalyell * observed the reproduction of both ends in *Sabella pavonia* (his *Amphitrite ventilabrum*). Grube and De St. Joseph subsequently found a similar condition in the same species. C. Vaney and A. Conte † described regeneration after experiments in *Spirographis spallanzani*. Ivanow ‡ and Orlandi § respectively studied the same species in regeneration. Grube ‖ found renewal of the anterior region in *Potamilla reniformis* and De St. Joseph ¶ in *P. forelli*, with regeneration of the branchiæ in *Myxicola dinardensis* and in *Dasychone bombyx*. Soulier **, again, describes regeneration of the branchiæ in *Branchiomma vesiculosum*.

One of the most complete accounts of the regeneration of the anterior and posterior ends of a sedentary annelid is that of P. Ivanow ‡ (1908) in *Spirographis spallanzani*. Both text and figures are full of interest—especially as regards the nervous system and segmental organs. Many authors, however, describe bifid posterior ends of other species.

The Sabellidæ, like the Terebellidæ, are stated by Dr. Goodrich †† to possess nephridia which open internally, and that the genital funnel becomes connected with the nephrostome and loses its primitive opening to the exterior.

An account of the "cartilaginous" substance in the branchiæ of *Spirographis spallanzani*, *Branchiomma köllikeri*, *Sabella reniformis*, and *Sabella infundibulum* is given by

* 'Powers of the Creator,' vol. ii. p. 225 (1853).
† Bull. Mus. Hist. Nat. t. xiv. (1908).
‡ Zeitsch. f. w. Zool. Bd. xci. p. 511, Taf. xx.-xxii.
§ Archiv. Zool. Napoli, vol. iii. 2 fig. (1906).
‖ 'Ein Ausflug-Triest u. Quarnero,' 1861.
¶ "Annél. Dinard," Ann. Sc. Nat. 7 sér.
** Trans. Instit. Zool. Montpelier, 1891.
†† Quart. Journ. Micros. Sc. vol. xliii. n. s. p. 740.

Nowikoff* (1912), illustrated by representations of stained sections, which indicate the position of muscles, nerves, and blood-vessels as well as the skeletogenous elements. He regards the supporting substance as homologous with that in Mollusca and Vertebrates, presenting, moreover, less polygonal or somewhat rounded cells, with ground-substance of a chondro-mucoid character, with nuclei and protoplasmic contents, and having externally a layer, which he terms perichondrium, upon which the cuticle and its nuclei rest. The author does not go into the distribution of the skeleton in the foregoing forms, but confines his attention chiefly to the histology of the tissue, the so-called "cartilage"-cells being filled with fluid, and almost resemble plant-cells from their distinctness. They possess one, rarely two, nuclei. The perichondrium is granular and has an alveolar (basement-) layer between it and the hypoderm.

The structure of the body-wall in *Sabella penicillus*, L., is typical, though there are special developments of the surface. Thus, on each side of the mid-ventral line a thick glandular layer outside the circular muscular coat occurs. This appears to be a special development beneath the hypoderm, which is readily traced over it and along each side of the mid-ventral fissure. The circular muscular coat is well developed and is continuous or nearly so. The dorsal longitudinal muscles are in section thick externally, but taper to the mid-dorsal line, where a hiatus for the suspensory mesentery of the alimentary canal occurs. These muscles are comparatively narrow and do not reach the lateral edge. In the same way the ventral longitudinal muscles are compact or almond-shaped in section, slightly thinned internally, and each is separated by a wide gap from the muscle of the opposite side. Both dorsal and ventral longitudinal muscles have a translucent sarcolemma on the free surface and both show bands of sarcolemma here and there cutting the mass into various fasciculi. Under the inner edge of each lies the nerve-trunk surrounded by neurilemma and with comparatively little neuroglia. On the upper and inner edge of each is a large neural canal, which in many sections is larger than the nerve-trunk and is occupied by a coagulable material. It appears to be unnecessary to call such a tube a giant nerve-fibre, and, indeed, the term neural canal was adopted in 1877†, and may as well comprehend the finer

* Zeitsch. f. w. Zool. Bd. ciii. p. 686, Taf. xvi.

† "On the Arrangement and Relations of the Great Nerve-cords in the Marine Annelids," Proceed. Roy. Soc. Edin. Session 1876–77.

canals, which can be traced into nerve-cells. An intricate series of fibres in transverse section occurs in the middle line between the nerve-cords and surrounds a small granular area above and another below. In each segment (probably at the junction) a very complex series of fibres—chiefly transverse and oblique—commingle over the nerve-area, whilst in the intermediate regions the ventral vessel and the muscular fibres and mesentery attached to the lower edge of the alimentary canal are more distinct. The alimentary canal itself is normal in section, and it has large blood-sinuses and vessels on its wall, besides the dorsal trunk (in its region). The thoracic glands occur in front, and the segmental organ lies to the exterior of the ventral longitudinal muscle.

Toward the posterior end, whilst little change takes place in the hypoderm and the ventral subhypodermic belt, or in the circular muscular coat, the dorsal longitudinal muscles are considerably extended laterally, whereas the ventral longitudinal muscles are diminished in transverse diameter and have the bristles close to their outer edge. The nerve-cords occupy the same position at the inner edge of the muscles and next the circular coat, the neural canal having about the same proportional size as in front. The complex crossing of fibres above the area occurs at intervals as in front. The gut in this region is filled with dark sandy mud.

Branchial Apparatus.—One of the most interesting featur s in the structure of the Sabellids, such as *Bispira volutacornis*, Montagu, is the chordoid skeleton which supports the branchial apparatus, and which commences behind the brain as a small lateral area (Pl. III. fig. 15, *ch.*), which soon develops into an arc on each side (Pl. I. fig. 1, *ch.*). About the region of the brain the lateral arcs fuse in the mid-dorsal line (Pl. I. fig. 2, *ch.*) and thus form a continuous curved belt from side to side, not, however, of uniform breadth in a given section, but with indentations, as at the large cœlomic area dorsad of the brain or at the enlargements laterally. This chordoid tissue is finely reticulated in the adult, more distinctly cellular in the young, the connecting walls staining slightly, and nuclei are very evident, especially in young examples. It is bounded externally by the firm investment or "perichondrium," the basement-tissue and muscular layers, hypodermic and articular, whilst internally it is bounded by the same homogeneous border of "perichondrium" to which muscles are attached. This "perichondrial" boundary (Pl. II. fig. 10, *pr.*) is not a separate layer, but processes from its inner edge all round pass as bridles to the reticulations and cells composing the interior, so that the two are modifications of the same tissue, the whole organically connected

as a stout supporting layer externally and a central region of complex reticulations. There is thus a considerable divergence from the bone-forming periosteum or the perichondrium of vertebrate cartilage, though the structureless matrix of the latter with its enclosed cells comes nearest. The great mass of this chordoid skeleton is dorsal, as are also the ganglia, whilst the great nerve-cords rapidly seek a ventral position, the former being above the alimentary canal, the latter beneath it. The muscular fibres on the inner curve of the chordoid skeleton about the level of the open vestibule—that is, before the closure to form the œsophagus—are not longitudinal, but oblique or vertical, stretching from the lower part of the inner concavity to the upper part of the arch, so that they would shorten the curve. Moreover, the "perichondrial" border shows large reticulations on its inner edge, a feature of importance in the elasticity of the parts during the varied movements (Pl. II. fig. 10). The inner border of this tissue widens at the level of the full development of the apparatus, and at its broad lateral part the sides of the curve projecting outward are laced together by muscular fibres, so that the curve—acute as it is—can be shortened. At this level also the chordoid central area is strengthened by special processes of the marginal tissue ("perichondrial" of authors). At the origin, again, of the chordoid skeleton (Pl. III. fig. 15, *ch.*) transverse muscles connect the two sides, and mesenterial fibres pass from their lower edge to the œsophagus, whilst the common duct of the thoracic glands is clasped by the strands. It forms a protective shield and support to the two great vascular trunks, the cœlomic spaces, and to the cephalic ganglia, whilst stiffening the attachments of the muscles of the region; indeed, in extent, it exceeds the cephalic skeleton of the cuttlefishes, and yet it has a certain degree of elasticity in the varied and graceful movements associated with the display of the branchiæ. Passing forward the lateral regions of this chordoid skeleton enlarge and begin to present intruding pillars, cutting the outer edge into regular spaces with convex margins externally, the first indication of the bases of the branchial filaments. Then the chordoid tissue arranges itself in long lobes connected with a narrow and rapidly diminishing inner belt of the same tissue, and this is soon followed by the disappearance of the inner belt and the inner portion of each lobe, leaving only a rounded or ovoid chordoid area marking the origin of each filament (Pl. II. fig. 12). The space occupied by the chordoid arch is now the seat of a series of radially arranged muscular bands, two for each filament, a connective-tissue septum from each chordoid oval passing in transverse section

between them. The cuticle and hypoderm externally become crenate and then notched, whilst spaces or slits appear between the chordoid ovals, by-and-by pass to the surface, and thus truncated fillets representing the separate filaments are formed all round the edge of the branchial base. The outer edge of each has a thick coat of hypoderm under the cuticle, but this diminishes internally on the sides, becoming thinner in its progress inward, the whole area resembling a narrow wedge with the broad end outside (Pl. II. fig. 12). Within the broad end is the basement-membrane and a "perichondrial" area surrounding the chordoid oval from which the median strand passes inward to support the blood-vessel. In this region the bases of the filaments and their axes are joined by a long band of the "perichondrial" substance, the appearance after partial maceration resembling a chain of *Perophora listeri* or similar series of tunicate stolons.

The two bands of muscle then show signs of diminution. Just before the filaments separate, small clear spaces occur at somewhat regular intervals in the interfilamentar tissue, but they are not visible after separation. At this level the sections of the bases of the filaments have their longest diameter radial (Pl. II. fig. 12), but this by-and-by shortens, and their inner border separates from the internal lining at the base, and each forms an independent filament, the muscular fibres, meanwhile, gradually diminishing. The chordoid cells in these form a double row (Pl. II. fig. 12), sometimes with two nuclei, but generally with a single nucleus in each, and the number of cells diminishes in the distal parts of the filament (Pl. I. fig. 4). When a pinna is cut longitudinally, a double row of cells is present in the sections (Pl. I. figs. 5 & 6), besides the external investment, or, as the knife slants superficially, the closer lines indicating the cells of the hypoderm intrude, as at the lower part of the drawing (fig. 6). The nerve occupies an area near the ciliated groove at the inner border. The double character of the slits is still preserved, for one-half of the inner joins that of its neighbour to the right, and the other that to the left. Then the diameter of each filament, now free, still further diminishes, and the blood-vessel is separated from the chordoid skeleton only by a narrow belt of connective tissue. Moreover, a double row of pinnæ springs from the inner and narrower edge, the outer having its thicker belt of hypoderm and its more massive connective-tissue layer and nerve internally. A single row of chordoid cells passes from the chordoid oval into each pinna as its skeletogenous rod, and thus the whole system is continuous from its massive

base to the threads in the delicate pinnæ, which have a thick coat of hypoderm and a ciliated cuticle. In the young *Bispira* the chordoid cells are especially large and distinct.

The branchial skeleton thus springing from a firm base spreads forward (or, as usually described, "upward") as a vase- or funnel-shaped sheet, binding together the bases of the filaments and, finally, dividing into the isolated rods for the filaments and pinnules. At the origin of the filaments the skeletogenous tissue forms a broad belt, continuous externally as a narrow rim, and having within this a small group of the chordoid reticulations, then a series of skeletogenous areas (in section) sometimes with marginal muscles, indicating the rudiments of the filaments. The chordoid reticulations then become more numerous, the "perichondrial" area diminishes, the soft parts increase, and by-and-by the separate filament is evolved. The chordoid rods to the pinnules appear to pierce—if such an expression can be used in connection with this continuous tissue—the "perichondrial" investment of each filament, and come into contact with the reticulations at the outer part of each. The whole chordoid skeleton is, however, a continuous structure, and it is only the continuity of the areolæ of the pinnules with those of the filaments which makes the use of the term "piercing the perichondrium" intelligible. A comparison of the adult and young specimens of the annelid show that the nuclei are remarkably distinct in the latter, whilst the smaller number and proportional larger size of the cells are features of moment. Many previous authors having used, in connection with this skeletogenous tissue, terms which would imply separate tissues, it has been necessary to insist on the unity of the structure as a whole.

Another feature of the chordoid skeleton is its connection with the shedding of the whole branchial apparatus in the Sabellids, for all the chordoid tissue appears to be thrown off with the branchial fans and the tentacles, the funnel-shaped anterior or distal portion consisting largely of this tissue covered by the integuments. The vessels on the proximal side would thus be more readily constricted, and an active surface for the reproduction of the apparatus uncovered. Whether this shedding of the branchial fans occurs frequently in nature is an open question, but the annelids in confinement sometimes do so.

The branchial fans double inward at their ventral base as a thin lamina with miniature filaments, each with its chordoid axis, and along the inner border of each the nerve-strands occur.

The tentacles (Pl. I. fig. 3, *t.*) belong to the branchial system, and separate in such a form as this and probably in all or many Sabellids, along with the branchiæ, which in their normal line of separation show a notch between the symmetrically curved chordoid basal support, which unites the halves above the gap by a firm bar of similar tissue. A little beyond the outer edge of this bar on each side springs a tentacle, the spout-shaped external basal fold of which is deeply pigmented with brown in *Bispira*. The inner basal web of each runs forward on the first dorsal branchia, whilst the outer web forms a free flap, the important furrow from the base of the branchial fan lying between them, and it is this groove which is pigmented. The tentacle itself is continuous with the inner flap or base, and presents a somewhat thicker median rib supported by the chordoid skeleton, the whole tapering to a delicate tip. Its nerve is of considerable size, and the organ is probably of great importance in regard to the nature and contents of the currents swept through the groove. Claparède * applied the term "tentacle" to the inner lateral fold of the mouth in his sections, but such is a wholly different structure from the tentacle as here described, and performs a different function.

In transverse section the tentacle, when fairly formed, presents a rounded axial region and two flaps or lamellæ arranged in opposite curves (Pl. I. fig. 7). The curves of the lateral flaps or wings are diagnostic, and indicate special functions, one flap curving to the left of the central region and the other more or less to the right in transverse section. Over the whole is the cuticle, then a layer of short nucleated epithelium resting on a basement-tissue, and within it a consistent connective tissue and probably muscular fibres, though these are indistinct on the wings. The central region is more or less rounded in section, with a tough cuticle and thinner hypoderm, but it is supported by a transparent skeletogenous axis containing a homogeneous substance surrounded by granules, whilst on one side (that furthest from the curved flaps) is a band of muscular fibres and on the other a nerve. The fact that this homogeneous substance does not stain would point to its solidity or coagulability. It is noteworthy that in the marginal line of filaments connected by the "perichondrial" strand, similar appearances, without the granules, in section are found, so that the tinted centre may be of the same "perichondrial"

* Annél. Sédent. pl. i. fig. 1, *tt.*

substance. The curve of the larger flap, which appears to be normal, would seem to show that the connective tissue in its middle is more or less elastic. Viewed in section the central rib presents cuticular and hypodermic coverings, then the transparent skeletogenous layer, which shows no evidence of cameration, and in the centre the tinted coagulable substance surrounded by the granules. In all probability this is a blood-vessel, and a trunk is seen in other forms, such as *Spirographis*, running up the centre of the skeletogenous sheath which ends in a delicate tip; and in the basal region of the tentacle numerous fine twigs ramify in the tissues. In sections from the tip downward the longer curved flap lies within the outer branchial row, between it and the tip of the inner row, and it has a blood-vessel at its edge.

Nervous System.—The cephalic ganglia in section (Pl. I. fig. 1, *cg.*) form two ovoid masses, connected by a broad commissure, and situated about the commencement of the chordoid skeleton of the region. The outer and more cellular part of each ganglion stains slightly, whilst the inner region and the commissure are pale. Moreover, at the outer edge of each mass is a pale area in section surrounded by brown pigment apparently representing an eye (Pl. III. fig. 14, *oc.*), and thus akin to the deep-seated eye of the ammocete stage of the lamprey, though it does not reach the surface in adult life. The capsule is consistent and stains, the centre being pale as if functioning as a lens, whilst the brown pigment seems to be chiefly massed on the inner border. Between the dorsal mass of muscle and the ganglia is a large vascular trunk on each side—the branchial—besides a closely reticulated tissue, the same tissue occurring laterally where the lower ends of the muscles cease; whilst the œsophagusis in the middle line below the commissure, and its sheath of muscle and connective tissue abuts inferiorly on a broad glandular hypodermic area ventrally, the apex of which is joined to the œsophageal sheath by the same reticulated connective tissue mentioned previously. In front of the ganglia a large cœlomic space and a vascular trunk lie at the base of the branchial apparatus before separation into branches for the filaments.

The sections, at the separation of the great nerve-cords from the cephalic ganglia were somewhat imperfect, but these trunks appeared to follow a similar course to those of *Spirographis*, as described and figured by Meyer* and others.

* Mitt. Zool. Stat. Neapel, Bd. vii. Taf. xxiii. fig., and Bd. viii. pp. 537–569.

The great cords after the disappearance of the eyes pass downward with their cellular sheath to the sides of the œsophagus (Pl. III. fig. 15), having beneath them only the dense mass of the ventral glandular hypoderm, the œsophagus being surrounded by the tissues of the region before this takes place, and, as those around the organ are chiefly muscular, firm constriction of this part can readily occur, the distinction between this region, imbedded as the gullet is in firm contractile tissues (Pl. II. figs. 8 & 9), and that which follows—in which the canal is more or less free—is therefore marked. Proceeding backward the œsophagus is fixed by a median mesentery ventrally and by various strands dorsally to a transverse sheet above it and the nerve-cords, a space, divided into two by a median muscle, occurring above —that is, below the dorsal longitudinal muscles (Pl. II. fig. 8). The nerve-cords with their investment then pass below the level of the alimentary canal and lie at some distance from each other at the inner border of the ventral longitudinal muscles, the ventral blood-vessel being between them and the massive ventral hypoderm externally. A small neural canal is now visible at their upper and inner border, no trace of this having been observed previously, as the great cords lay at the sides of the gullet. Passing gradually downward the cords are enclosed by fibres from the circular coat crossing above and below them (Pl. II. fig. 8), the small neural canal, sometimes two, being visible—for instance, at the ganglia in the nerve-sheath at the upper and inner angle of each. The nerve-cells are confined for the most part to the exterior investment of the ganglia and the trunks, though some are in the substance of both. The transverse (circular) fibres above the cords increase in strength, and are further stiffened by the fusion of strong muscular fibres from the sheath of the alimentary canal in the middle line. Other fibres pass outside the cords, and even between them in the intervals between the ganglia, so that in this region they are well supported and they are nearer each other than in front. The transverse (circular) fibres above the cords remain after the muscular band from the gut disappears and a median mesentery takes its place, whilst the small neural canal shows little change. Proceeding backward, the ventral blood-vessel is surrounded by a thick ring of muscular and connective-tissue fibres fixed ventrally between the neural canals and beyond them. The neural canals are now considerably larger, and the gut and the ventral vessel are connected with the slender transverse fibres by a thin mesentery; but this only lasts for a short distance, when the thick investment of the trunk again appears in the progress

backward, so that an intermittent arrangement is present, a feature probably due to the intervals between the thicker mesenterial bands from the gut, these bands being composed of fibres studded with nuclei; and the fibres cross each other on their way to those beneath the cords in the interganglionic areas. The neural canal is sometimes double on one side, single on the other. At the thickened perivascular areas the gut touches or is sessile on the coat of the vessel. In the intermediate regions, where the vessel hangs in a thin mesentery, it has a pigmented coat of clavate chloragogen-cells (Pl. III. fig. 17, *chl.*), the broad end being external, so that they form an arc on each side. The secretion of these, no doubt, is of some importance in connection with the vascular trunk and the cœlom *. Anteriorly, when the thickened coat occurs, the pigmented cells are placed to the exterior of the arch on the cœlomic surface, but, by-and-by, in the progress backward they are grouped inside the channel of the tube on the blood-vessel, and this continues till it again is free. The great cords are now more rounded in section, with the neural canals at their upper border or at their outer and upper border, and on the right side in one case two are present, the larger almost extra-neural and pressing into the border of the ventral muscle. Comparatively few cells occur in the interganglionic areas, the general surface of the cords in section being finely granular and somewhat reticulated so as to form rounded areas. The cells increase at the ganglionic regions, and appear chiefly in the neuroglia, only a few occurring in the commissural band. Posteriorly, the cords in section at a commissure are placed close together with the neural canals between them, the nuclei of the neuroglia scattered thinly in their area in section and more thickly exteriorly.

A short distance behind the foregoing the body-wall assumes its normal arrangement, the ventral longitudinal muscles lying within the hypoderm, basement-tissue, and circular coat, whilst the nerve-cords and the intermediate ventral blood-vessel occupy the space between their inner ends. Each cord has the circular muscular coat, the basement-tissue, and the glandular mass of the shield externally, with its fibrous area inferiorly, and above it is the now large neural canal, which has a firm wall and usually a coagulum

* In a large example a peculiar and symmetrical appearance was caused anteriorly by the intrusion of the massive ventral coat of hypoderm on each side of the cords and their ganglia, so as to form an arborescent mass above and on each side over the inner ends of the ventral longitudinal muscles. Such probably was due to pressure in preparation.

in its lumen, the edge of which stains deeply. A reticulated investment (neurilemma) separates it from the ventral blood-vessel, and a firm layer of the same tissue roofs in the entire area, the fibres of which closely link it on to the alimentary canal immediately above. The neural canal soon becomes as large as the section of the nerve, and, as mentioned, it seems unnecessary to term it a "giant fibre."

Cunningham* (1888) is inclined to regard the neural canals as supporting structures, which prevent the nerve-cords being bent at a sharp angle, and where they are highly developed the cords are not separated from the epidermis. He states they have a position similar to that of the notochord in relation to the neurochord and aorta. He failed to trace a connection between these canals and any ganglion-cell, whilst admitting their homology with those of the Errant annelids.

In a section of a young *Bispira* stained with Ehrlich's hæmatoxylin, the cephalic ganglia are rather widely separated, for they occupy the upper and outer border of the vestibule leading to the mouth, and which has the outline dorsally of the letter M. To the exterior is a pale belt free from cells, then a band of muscular fibres inside the chordoid layer with its investment, whilst the cuticle and hypoderm form the superficial coverings. The chordoid cells are large, distinct, and transparent, each with its nucleus, and sometimes with two, and they form at the level of the brain a horseshoe guard on the dorso-lateral region, the ventral aspect of the ganglia abutting to a large extent on the mucous membrane of the vestibule, the isthmus between them following the descending bars of the M in its progress from side to side. Moreover, in contact with the isthmus dorsally are the basement-membrane and the hypoderm of the cephalic *cul-de-sac* in free communication with the sea water. The organ thus is in a favourable position for receiving impressions from the exterior as well as by its nerve-trunks, whilst the elastic chordoid skeleton gives sufficient protection. In the transverse sections the entire ganglion on each side is dotted with deeply stained nerve-cells, which perhaps are most numerous toward the surface, and they extend into the nerve-trunks, leaving the organ, as well as being distributed on the isthmus from side to side. In some cases they are grouped in arcs with the pale neuroglia between, as if pertaining to a lobule, but, as a rule, there is little definition in this respect. Immediately behind, the

* Quart. Journ. Micros. Sc. n. s. vol. xxviii. p. 275.

nerve-mass bulges ventrally at the sides of the vestibule, and the trend of the intervening commissure is more or less straight—from the change in the roof of the vestibule, the central lines of the M being more or less obliterated.

The eyes (Pl. III. fig. 14) do not appear in the sections until the protective chordoid tissue has diminished to a small arc above the posterior region of the cephalic ganglia, and when a mere chink above the gullet indicates the external pit in communication with the sea-water. The œsophagus itself is now enclosed in connective tissue and circular muscular fibres. The eyes rest on the ganglia, and the great trunks arise near, and show a pale faintly granular central area and a thick investment of neuroglial cells. The eyes have dense brown pigment-cells apparently radially arranged round a pale region, which probably represents a lens, a thinner layer of the pigment occurring on one side of the elliptical organ according to the level of the section. In some sections a pale spot appears in the centre of the pale brownish median region, the dark pigment forming a belt exteriorly. These eyes appear to be similar to those Meyer * found in *Psygmobranchus protensus* (=*Protula tubularia*, Mont.) and *Amphiglena mediterranea*.

In *Serpula contortuplicata* (= *Hydroides norvegica*) De Quatrefages describes the cephalic ganglia as large and only separated by a constriction in the middle line, and giving off from each side a large branch to the branchiæ. The œsophageal connectives are longer than in *Sabella*, and from the first widely separated pair of ganglia a considerable trunk passes to the "voile palléal" (the thoracic membrane). The ventral cords remain separate, and ganglia connected by a slender commissure occur in every segment. The trunks are wider apart anteriorly than posteriorly.

Muscular System and Body-wall.—About the level of the brain muscular fibres are fixed to the inner wall of the chordoid skeleton (Pl. II. fig. 10, *m.*), which here attains great development, and their general trend shows that they draw the horseshoe bend of the skeleton close. Proceeding backward, a strong longitudinal muscle (Pl. I. fig. 1, *m.*) appears at the ventral end of the diminished chordoid area, and a smaller muscle above the skeleton, and the disappearance of the skeleton permits this muscle to form a continuous curved sheet, widest below, in the area formerly occupied by the skeleton, and it soon approaches its fellow of the opposite side, separated only by a series of transverse

* Mitt. Zool. Stat. Neapel, Bd. vii. Taf. xxiv. fig. 14.

fibres which connected the inner ends of the vanishing skeleton. Externally are circular fibres, which pass downward to a firm connective-tissue area at each side of the massive ventral hypoderm. This great muscular sheet is most massive below, where it supports the origins of the great nerve-trunks. At first no differentiation of the sheet is observable; then pale connective-tissue fibres appear in its middle opposite the upper end of the nerve-masses, and in this an aperture appears, its cavity being surrounded by stained granules, and now it is seen that there are two longitudinal muscles, an upper and somewhat smaller rounded muscle, which projects dorsally on each side of the median groove, and a larger ovoid muscle at the outer side of the nerve-trunk, the two being separated on each side by an increasing cœlomic area. The two dorsal muscles are separated by a space, crossed by the circular fibres of the body-wall, and others passing from the inner edge of the muscle and from the six or more vertical bands from the alimentary canal. The hypoderm covering the prominence of these muscles dorsally is specially thickened. The second or ventral pair of muscles are still lateral in position, have the circular fibres, basement-tissue, and hypoderm externally, the nerve-cords and neuroglia internally, and connective-tissue bands and the hypoderm below. The dorsal muscles remain more or less rounded in section (Pl. II. figs. 8 & 9, *dm.*), but the ventral muscles become somewhat longer, more oblique in position, and the nerve-cords now lie below their inner edge inferiorly. Their elongation and obliquity increase in the following sections, for they assume a spindle-like outline, their limiting fibres fusing across the middle line with each other and with those from the vertical bands and those surrounding the gut, whilst the nerve-cords now lie below this fibrous isthmus, with a small neural canal in the neuroglia of their upper and inner border. The dorsal muscles are still rounded or ovoid, separated by a considerable interval in the middle line and wholly dorsal in position, but they by-and-by become pear-shaped in section, pointed mid-dorsally, and thicker externally; moreover, they slope a little downward and laterally. The ventral muscles stretch upward almost to the dorsal bristle-tuft, and are thus longer than the former (Pl. II. fig. 8, *vm.*)—indeed, their mass exceeds that of the dorsal, a condition so different from that in *Pomatocerus*. The dorsal muscles do not meet in the middle line, though thinned like the ventral in expansion of the body-cavity, and they are still less in bulk

than the ventral. The oblique are long and slender, and are fixed over the outer part of the nerve-trunks.

Passing backward, in the anterior region, the dorsal muscles increase in bulk and pass further downward, the dorsal arch of the body being better developed, and the feet having taken a lateral position somewhat below the middle line. A median hiatus still occurs dorsally, and the muscles increase in thickness from this downward until reaching the blunt cone inferiorly. The ventral longitudinal muscles are sausage-shaped in section and now not half the bulk of the dorsal.

In the middle of the body of *Bispira* the walls have assumed the normal arrangement, the hypoderm being thin dorsally, thickened laterally, especially on the processes, and considerably diminished (from that in the front) in the mid-ventral line, the ventral area in section being that of a gracefully curved spindle, massive in the middle below the nerves, tapering off at each side, and again having thickened glandular areas in the lateral region with its processes. The dorsal longitudinal muscles are larger, somewhat thinned toward the dorsal middle line, where there is no distinct hiatus at the attachment of the mesentery, and the curve on each side increases in breadth to the lateral processes, where it bends slightly inward, and in some a slight median projection or keel occurs to which the median mesentery is attached. These muscles are lined by the cœlomic cells with nuclei. The fasciculi in section are fibrillar, and they abut externally on the somewhat thin circular coat and internally on the cœlomic surface. The ventral longitudinal muscles are less in bulk and more compact, but have similar fasciculi, each having a blunt point in section sloped upward and inward at the nerve-cord, slightly tapered and rounded at the external edge. In the interganglionic areas the nerve-cords have the support of the muscle on each side, the inner end often rising above them, and a deep hollow, in which the blood-vessel and its mesentery lie, between them. The neural canals are slightly larger than in front, an additional smaller canal in one case being within the larger on the right, and the investment of each is firm, with a few nuclei, and the usual coagulable contents. They occupy the upper and inner region of each trunk, though a small one occasionally is seen toward the lower border of the cord at the ganglia. The alternation of the slender ventral mesentery with its pigmented cells free in the cœlom, and the massive tunnel of crossed fibres with the vessel and its cells inside, and others along the cœlomic wall adjoining

till continues. The gut in the middle of the body is capable of great dilatation, and there is a slight separation of the dorsal longitudinal fibres in the mid-dorsal line, but the fasciculi are similar to those in front, and the muscles are broader—that is, stretch further downward. On the other hand, the ventral muscles are more compact, and the hypoderm in the mid-ventral arc has diminished and shows a furrow ("copragogue") in the centre, and the sides project a little. The area of the nerve-cords in section is smaller, and the neural canals are proportionally larger. The same alternation of the muscular arches and tunnels with the free mesentery and its vessel occurs, but the ventral longitudinal muscles are thicker, their transverse diameter less, and their inner ends rise much above the nerve-cords, though these ends are thinner than the outer in section. The dorsal longitudinal muscles have attained great preponderance in bulk. In this region muscular fibres pass downward by the side of the gut and from the inner border of the lower mass of the dorsal longitudinal muscles, and cause, by passing through the fasciculi of the ventral sheet, a differentiation into an inner and outer belt at intervals.

Posteriorly the chief changes are the diminution and flattening of the body-wall, the great lateral expansion of the dorsal longitudinal muscles, so that each has a clavate outline in section, and a median hiatus, to which the mesentery goes, is present. The ventral muscles have proportionally increased in bulk and each is also clavate in section, the broad end being exterior, but they do not project above the great nerve-cords as in the middle region of the body. One of the most evident changes is the appearance of vertical bands of muscles which connect the dorsal with the ventral longitudinal muscles on each side of the alimentary canal, and they penetrate the fasciculi in both to the basement-membrane. The nerves and the neural canals are likewise diminished. Toward the tip of the tail an increase in the hypoderm takes place all round, the shrunken muscles rendering this more conspicuous, the dorsal longitudinal thinning off in the middle line much more than the ventral, so that the gut occupies the dorsal arch, whilst a thick mass of hypoderm occurs ventrally.

The muscles of the spines and bristles follow the same plan throughout, forming a fan-like or radiating series in each case.

Bristles.—When the setigerous process in the middle of the body is cut at right angles to its long axis two groups of bristles are found, a more compact series arranged in a

somewhat spiral manner, and an outer series forming a single curve, the larger bristles in this case being above and the smaller at the ventral end.

Circulation.—In transverse sections from the tip of the branchial fan backward it is found that a clear space, it may be with a translucent coagulum in the centre, appears on the inner curve of each fan dorsally and soon is surrounded by a well-defined nucleated wall. Passing backward the trunk has a curved lamina attached to it about the level of the fused branchial filaments, and then it occupies a larger internal lamella, with the curved membrane distally. Before the chordoid skeleton appears the two trunks are imbedded in the folds, which by-and-by lead to the mouth, being situated on each side of the median fissure (Pl. I. fig. 2, *bv.*), when only slight crenations mark the incipient filaments with their chordoid skeleton, the central chordoid mass having disappeared. These trunks would seem to arise from the division of the dorsal vessel anteriorly, but the sections of the region did not afford absolute proof. Moreover, it has to be noted that, if these are vessels, their contents are devoid of the minute corpuscles present in the trunks elsewhere. Anteriorly the dorsal blood-vessel splits into two great trunks for the branchial fan, and each of these at the level of the chordoid skeleton divides into a series for the filaments, the whole in section having the aspect of a rosette (Pl. I. fig. 2, *bv.*). In the middle of the body the dorsal vessel has disappeared, and a plexus or blood-sinus surrounds the gut, whilst the ventral vessel remains as before; and this conditions remains to the posterior end.

In a series of sections of a large example in which the thoracic glands were unusually spacious, but which (preparation) had been overheated and damaged, deeply stained granular masses occurred inside the membranous sheath around the gullet, such probably representing the blood in the large sinus, though it might be mistaken for masses of sperms.

At the level of the brain in transverse section the ventral attachment of the collar occurs on each side of the central glandular area, the cuticle and hypoderm of the body-wall bending outward and ensheathing the collar, that part of it, however, covering the central glandular area being much more cellular and granular as well as slightly thicker than the rest. Between the two layers of hypoderm the collar has connective-tissue fibres, cells, and probably muscular fibres, though the latter were not differentiated. The flaps

on the sides of the dorsal furrows have the same structure and all are modifications of the wall of the body.

Alimentary Canal.—The aperture of the mouth, fed by the grooves from the branchial fan, besides those elsewhere described, and with its dorsal transverse fissure and the two lateral folds or lappets on each side below, soon assumes in section the form of a transverse slit, the dorsal epithelial wall of which is boldly scalloped or crenate, with two projections in the middle line, whilst the ventral is two-lobed—two prominent lobes or projections occurring on each side of the central fissure. Then, passing backward, the canal forms a long transverse or slightly fusiform slit, its epithelial surface becoming at the same time less dense, whilst various mesenterial strands are attached to its outer wall; but soon the epithelial lining diminishes in depth and the canal becomes more capacious—shorter in transverse and longer in vertical diameter; its walls increasing in thickness, and its muscular and mesenterial strands more numerous. Thereafter its inner lining is thrown into narrow longitudinal ridges, and strong muscular fibres are attached to its outer surface. The great increase of the mucous lining and the diminution of the diameter of the canal cause the organ in section to be ovoid or even rounded, the entire area being occupied by the folds of the inner lining and the basement-tissue—circular and radiating fibres externally giving firmness to the rounded canal (Pl. I. fig. 1, *d.*). Then the mucous folds change their character, and the inner lining is thrown into slightly arborescent ridges in transverse section, somewhat after the fashion of the gizzard of certain Orthoptera, but it is not chitinous. Behind this, though still in the anterior or "thoracic" region, the canal retains the bold longitudinal ridges of the mucous surface, though they are less arborescent; the suspensory mesentery from the mid-dorsal arch is short and strong, and the walls of the gut are massive, since, besides the coats formerly mentioned, a reticulated connective-tissue layer with vascular spaces, as well as a chlorogogenous coat, surround it. Besides, it is further clasped by powerful vertical bands passing on each side from the dorsal longitudinal muscles to the area of the nerve-cords (Pl. II. fig. 8). The ventral blood-vessel lies in the thick investment immediately beneath it, and a complicated plexus of muscular and connective-tissue fibres takes place beneath the canal and above the ventral vessel in various sections at intervals. Posteriorly, the canal considerably diminishes and its internal surface is

marked by complex folds. Dorsally and externally is the median mesentery, whilst inferiorly is the ventral mesentery enclosing the blood-vessel, and at intervals the plexus of muscular fibres from the oblique muscles and the gut itself, making the arch over the ventral vessel.

Thoracic Glands.—The thoracic glands, or anterior segmental organs of some, have been the subject of various interpretations. Thus Ehrenberg* in *Amphicora sabella* and Grube in *Spirographis spallanzani* thought them reproductive organs. Oscar Schmidt† more or less followed this interpretation, though he associated them also with an excretory function. He describes them as two short sacs opposite the first bristle-bundle in *Amphicora mediterranea*, each with a duct leading obliquely forward to join its fellow and to open in the mid-dorsal line behind the branchiæ. Williams, again, did not allude to these organs, but located the segmental organs of Sabellids and Serpulids in every abdominal segment, each with an external and an internal opening. Leydig and Huxley (the latter in *Filograna*) added little more than a notice of them. De Quatrefages considered them in the Serpulids as blind hepatic sacs connected with the stomach. Claparède (1870) thought them modified segmental organs which in the Serpulids secreted mucus, the ordinary segmental organs occurring in all the abdominal segments of such as *Psygmobranchus*. Cosmovici interpreted them as excretory organs or "Organs of Bojanus"; whilst the segmental organs in the posterior region transmitted the ova and sperms. Langerhans termed them head-glands in *Sabella* (*Potamilla*) *stichophthalmus* and *Euchone rosea*, and that they opened dorsally. A. G. Bourne‡ (1883) considered these organs in *Haplobranchus* tubiparous glands or modified nephridia, and he mentions no ducts.

In his account of the segmental organs of *Branchiomma* Brunotte§ describes, after Claparède, the thoracic glands as thoracic segmental organs, and situated in the first and second segments, thus being less developed than in *Spirographis spallanzani*, and even than in *Chætozone* and *Myxicola*, the former species having them in all the thoracic segments, the latter in more than two segments. The author interprets their structure as glands formed by the volutions of two tubes, and in his figures (pl. i. fig. 31, and pl. ii. fig. 40) shows the cœlom as filled by the coils of these, yet in pl. ii.

* Mitth. Verh. Ges. Nat. Freunde, Berlin, 1836.
† Neue Beiträge Naturges. der Würmer-Reise nach Faror, 1848, Jena.
‡ Quart. Journ. Micros. Soc. vol. xxiii. p. 168.
§ Recherches Anat. Branchiomma, p. 59 (1888).

fig. 38 only the section of a single tube on each side is indicated. This interpretation shows certain differences from the arrangement in *Bispira*. Brunotte's view that the walls of these tubes (individual folds) are specially arranged holds only good in *Bispira*, so far as it refers to folds of the appendicular duct posteriorly (Pl. II. fig. 11, *tg.*). The author is inclined to think that these thoracic segmental organs represent the series found in other forms, and are probably homologous with the longitudinal canal in *Lanice*.

The thoracic glands (anterior nephridia) in *Bispira* and other Sabellids follow a different arrangement from those in the Serpulids, *e. g. Pomatocerus*, which have their widest part anteriorly and diminish in their progress backward to a blind end. In longitudinal section these glands fill the cœlomic spaces of the first two segments in *Bispira*, which thus agrees with *Branchiomma* as described by Brunotte, though their convolutions would appear to be larger, such depending to a certain extent on the degree of contraction or expansion. In the serial (transverse) sections from the front the first trace observed is a small tube with pigmented walls situated about the level of the upper arch of the gullet, between the approximated dorsal and ventral longitudinal muscles, and it is imbedded in muscular fibres stretching from the gullet to the body-wall. Such represents the anterior duct of each side, thus corresponding to the arrangement in the Serpulids. The thoracic gland increases gradually in size and passes downward to the exterior of the œsophagus, resting on a plate of muscle passing outward to the wall and cutting off a cœlomic space above it on each side. Here the small tube has fixed to it a loop of vesicular and cellulo-granular tissue which seems akin to the chloragogenous investment of the gut, the cells and vesicles hanging on a thin mesenterial tissue in groups (Pl. II. fig. 11, *chl.*). The structure of the gland in section is similar to that in the Serpulids, but the walls are, perhaps, less massive than in *Pomatocerus*, though of considerable thickness, the tough external layer having muscular fibres within it and the epithelial layer being largely developed. With the increase of the cœlomic space the gland on each side moves downward and the cellular loop (really a tube) enlarges, and the sections of the gland lie within the ring of this tissue. Then sections of two glandular tubes appear, as if the organ had become bifid, both connected with the granular cellular tissue, the vesicles and cells projecting into the ring from the limiting membrane externally, and they form a thicker and more definite layer.

Moreover, that part of the wall of the vesicular tunnel adjoining the gut-wall applies itself to it, whilst the outer part of the cellular structure forms loops in connection with the thoracic glands, which when the sides are flattened present in section the aspect of a tube, as shown by Brunotte (his pl. i. fig. 21). Masses of cells with brown pigment occur on various parts of this cellular membrane, and the transparent cells themselves are often grouped near the oblique muscles as they pass to their insertion above and to the exterior border of the great nerve-trunks. A conspicuous feature at this level is the occurrence of a comparatively large aperture through the body-wall just below the bristle-tuft, the finished nature of which shows that it is a permanent structure, but whether in connection with the thoracic glands or otherwise the imperfection of the sections does not enable a decision to be made. The area of the thoracic glands is much larger than in front, the reverse of the condition in the Serpulids, and they form complex structures by folding or division. The complexity of these glands is best shown in longitudinal sections, and they fill up the cœlomic space in the first two segments. Brunotte describes them as double. Further, toward the posterior part of the glands one tube is found in section to the outer side of the fibres of the oblique muscle and has considerably diminished. Transverse sections of the smaller tubes present an investing membrane lined by nucleated cells probably with internal cilia, all the parts, including the thoracic gland proper, being more delicate and transparent than in *Pomatocerus*. Then the gland increases in area and shows various folds or pouches, and the vesicular and cellular strands become abundant, the main gland, to which these are attached, often presenting septa dividing it into two chambers. Finally, the gland and its tubular appendages disappear, only the translucent botryoidal tissue being left in strands connected with the mid-ventral region, and passing up to the dorsal longitudinal muscles. Besides the vesicles and cells attached to the membrane a small tube is seen in section, and, moreover, it is clear that this tissue is identical in structure with that attached to the wall of the gut, and nucleated strands pass beneath the canal to be attached to it above the ventral blood-vessel, probably separated from the gut-wall during preparation. Further backward the wall of the alimentary canal is free from this tissue, only a slight development of it taking place posteriorly.

Segmental Organs.—In the middle of the body a folded tube with transparent nucleated cells lies in the space above

the outer ends of the ventral longitudinal muscle. The nuclei along the sides of the tube stain deeply, thus outlining the canal which curves downward and outward and opens below the bristle-tuft external to the outer edge of the ventral muscle (Pl. II. fig. 13, *so.*). Nothing was seen of its internal connections except an occasional wider section. Separate masses of the deeply stained cells were noticed here and there, as if from folding or lobulation of the main tube, which in some cases appeared to form loops, and the vascular supply is abundant. Occasionally masses of minute cells were present toward the middle, attached by mesenteries to the other parts of the organs, and in section such were sometimes circular. The ducts seem to be smaller and longer posteriorly, and in some cases did not appear to be functional, especially toward the tip of the tail. Further investigations in this region are, however, necessary. When the nephridial tubes are cut longitudinally the nuclei ranged along each wall are conspicuous.

In *Amphiglena mediterranea* the chordoid arch supporting the branchiæ is narrow and composed of but two large cells from side to side of the middle of the bar, which is boldly curved ventrally at each end, whilst the central bar is concave dorsally beneath the dorsal groove—the whole having the form of certain bows, especially as a blunt conical projection occurs at each end of the transverse bar where the cells also are increased. The mouth in section in this region forms a vertical slit, bifid dorsally—that is, leaving a median pointed cone dorsally. The cephalic ganglia occupy a similar position to that of the typical forms. The pharynx soon forms a thick-walled tube rounded in section, and filled with granules and spicules, the mesentery holding the dorsal vessel above and the ventral inferiorly, the latter being close to the two nerve-cords which lie on the inner surface of the massive and continuous hypodermic glandular area of the region and at some distance from each other, the comparatively massive ventral longitudinal muscles being as yet to their outer border and wide apart, whilst the ventral blood-vessel is placed between them. No neural canals are present. Proceeding backward the ventral longitudinal muscles, which are now extended and comparatively thin, send their inner edges into the median groove formed in the centre of the ventral hypodermic mass, the nerve-cords, which were very indistinct in the preparations, apparently lying at the sides of the fissure, in the middle of which is the mesentery from the alimentary canal fixed to the distal end of the fissure. About the level of the nerve-cords is the

ventral blood-vessel which has remarkably thick walls, so that at first sight the mass resembles the halves of a narrow elliptical ganglion or flattened cord, after the character of that in *Arenicola*, since the actual cords are difficult to recognize. The thickness of the walls of the vascular trunk would indicate special contractility in this region. The hypoderm is thus divided into lateral lobes with a slight median ventral ridge, the whole being glandular.

The body-wall in *Dasychone dalyelli* (*argus*) has externally the cuticle and a thick hypoderm, and there is a glandular ventral belt of great depth as in *Sabella*, with a median notch. The circular muscular coat appears to be comparatively thin, though continuous. The dorsal longitudinal muscles are in section rather broad and thin, the thickest end being external, and a hiatus occurs in the mid-dorsal line. A considerable gap exists between the ventral longitudinal muscles, which are about the thickness of the dorsal, though narrower, and without curvature, apparently from the feebleness of the oblique muscles. At intervals somewhat powerful muscular bands slope downward and inward, to be attached to the complex area above the nerve-cords, but the system is less marked than in *Sabella*. The alimentary canal has its median dorsal and median ventral mesenteries. The nerve-trunks lie more distinctly under the inner edge of each ventral longitudinal muscle, and no neural canal is present. The fibres of the circular and oblique appear to cross between them, and from the trunks fibres radiate into the glandular coat outside. The ventral longitudinal muscular layer is often broken up into several fasciculi.

The structure of the body-wall in *Chone infundibuliformis*, Kröyer, introduces a new type into the series, were it only for the remarkably coiled arrangement of the muscular fasciculi of the longitudinal muscles in transverse section. The cuticle covers a hypoderm well developed and highly glandular throughout, the long cylindrical cells being characteristic, especially when slight softening of this coat occurs. In the mid-dorsal line is a deep groove, and its bottom and sides show a somewhat finer granular structure, so that it may be a more sensitive area than the general surface. A decided thickening of the hypoderm takes place in the mid-ventral line, and it tapers to the normal thickness in the ventro-lateral region. The circular muscular coat is well developed and continuous, modifications occurring at each foot. The dorsal longitudinal muscles are largely developed, and, like the ventral in section, are in two concentrically arranged bands, the outer layer, however, extending

over the dorsum of both. The median band is somewhat triangular with the pointed end internally, the outer is ovoid, and in the hiatus between the muscles of opposite sides the alimentary canal is suspended, and so closely that no mesentery is apparent—indeed, it would seem that the muscular fibres which pass from the circular coat into its walls form the suspensory apparatus. Ventrally the longitudinal muscles likewise form in transverse section two areas, in this case somewhat heart-shaped, the base of each being central, the apex external, and the outer (ventral) fillet of the muscle likewise extends over both areas. The inner edge of each muscle is separated by a considerable gap, in which lie the nerve-trunks which rest in a granular neuroglia, with the neurilemma and the circular muscular coat externally, whilst to their upper edge are attached strands from the alimentary canal. The two cords are surrounded by a sheath or neurilemma, and at the upper and inner angle is a small neural canal. At the ganglia the neurilemma is confined to the outer surface. In the mid-ventral line beneath them is a granular mass (in section) of neuroglia, and a trace also appears at each side, whilst in the region of the separate cords this inferior granular structure is thicker in the centre and tapers off laterally. On each side of the strands from the alimentary canal is a foliate granular mass (male elements ?), whilst between the strands is the ventral blood-vessel. Large vascular trunks or sinuses occur along the wall of the alimentary canal. The fan-like arrangement of the long hooks is well shown in such sections.

Somewhat behind the foregoing the mid-dorsal groove becomes only a slight depression, though the hypoderm retains the same character as in front and the cuticular surface appears to be ciliated. The hypoderm now forms a coat of nearly equal depth all over, though there is still a slight thickening in the mid-ventral line due apparently to increase in the basement-substance as well as in the hypoderm proper. The circular coat has increased in strength, the suspensory fibres for the alimentary canal are longer, and the canal itself shows both circular and longitudinal fibres, whilst the folds of the mucous surface are sometimes so arranged in the empty organ as to interlock. Strong fibres at intervals pass from the dorsal to the ventral region—grasping the alimentary canal at each side, and being attached to the fibres, including those of the oblique muscles, which form a complex around the ventral blood-vessel and over the nerve-cords. The latter have now, at

their upper part, a larger neural canal which in some sections exceeds in bulk the main mass of each nerve, as in Allen's *Pœcilochætus* *. The neuroglia external to the trunks has increased. The condition of the dorsal and ventral longitudinal muscles is the same as in front, the coiled arrangement of the fasciculi being conspicuous in section.

In a section about half an inch from the tip of the tail, no evident dorsal notch occurs in the hypoderm, but a deep groove exists between the thickened hypoderm on each side of the mid-ventral line. The circular muscular coat is still conspicuous. Each moiety of the dorsal longitudinal muscle is now separate, the outer coil dorsally leading externally to several folds wedged between the moieties, the inner being rounded and smaller than the outer moiety. A strong series of muscular fibres leaves the dorsum, joins the oblique, and passes to the ventral border on the outer side of the nerve-trunks. The arrangement of the coils in the ventral longitudinal muscles in section is as in front, viz., the outer or ventral band envelops both moieties which are irregularly rounded and the inner is the smaller. The alimentary canal is small, firm, and rounded, highly vascular, and fixed by the mesenteries as in front, its circular muscular coat being conspicuous. The nerve-cords have a considerable mass of neuroglia externally—that is, between them and the circular muscular coat. A small neural canal occurs at the upper and inner border of each, the nerve-tissue completely surrounding it.

In the *Dialychone acustica* of Claparède †, the two statocysts (otocysts) in the first segment are well developed, but the chief interest, in connection with the present remarks, is the characteristically coiled condition of both dorsal and ventral longitudinal muscles (on section) from the anterior end backward. The large size of the skeletogenous reticulations and their numerous nuclei are also features of note. In a female large ova occurred in the anterior thoracic region.

The body-wall in *Othonia* conforms to the general type of the family. In those having the body-cavity distended with comparatively large ova the muscular layers are somewhat thinner, and the alimentary canal forms an ellipse held by the dorsal and ventral mesenteries, the minute nerve-cords apparently having no neural canals.

In *Euchone analis* (about $\frac{1}{6}$ of an inch) from the front the

* Journ. M. B. A. vol. xlviii. p. 105.

† Annal. Chét. Neap. p. 432, pl. xxx. fig. 3.

hypoderm is greatly developed on the ventral surface, thinning off in the lateral regions, and with a slight groove mid-dorsally. The circular muscular coat is fairly developed all round. The dorsal longitudinal muscles form a continuous loop in transverse section, the broader end of each being external, and the short mesenterial attachment of the alimentary canal separates each muscle in the mid-dorsal line. The folds of the ventral longitudinal muscles are also apparently continuous in section, both these and the dorsal being somewhat lappet-shaped, the inner end being pointed, the internal fold of the muscles terminating before reaching the point in each case. The oblique muscles seem to be feeble and indistinct, each appearing as a thread-like process along the inner border of the ventral longitudinal muscle, and being attached over each nerve-cord. The alimentary canal (gullet) is large in this region, and has a firm exterior with circular and longitudinal muscular fibres, and a thick mucous coat, the nerve-cords are comparatively small and lie in the intervals between the ganglia in the middle line below the attachment of the mesentery from the gut. Externally are a mass of neuroglia, the circular muscular coat, and the much thickened hypoderm of the ventral surface, which shows no median groove in this region. The nerve-area is considerably larger when a ganglion is severed. The canal is ensheathed by a firm mesentery fixed on each side over the nerve-cords. A small canal occurs in the median line above the nerve-cords, and the gonads are at each side. The sheath of the alimentary canal is close to the vessel, thus differing from the usual condition of a free space between loose mesenteries.

A little ($\frac{1}{6}$ in.) behind the foregoing the ventral surface is marked by a deep groove, so that the thick hypoderm forms a crescentic mass on each side. The alimentary canal is much enlarged, and its lumen filled with folds of mucous membrane. The dorsal and ventral longitudinal muscles have the same structure in section.

Toward the posterior region of the body, whilst at first the ventral muscles indicate no change, the dorsal loop presents a hiatus at the ventral edge on each side of the middle line, from which apparently the homologues of the oblique muscles pass, the outer fold being enlarged next the fissure; such is the condition at $\frac{1}{5}$ of an inch from the tip of the tail. The whole aspect of each muscle, however, alters at about $\frac{1}{3}$ of an inch from the tip of the tail. Each dorsal muscle forms in section a continuous thick arch superiorly, the inner end bending downward and forming a

coil of a turn and a half, whilst the outer and thicker end does the same. Each ventral muscle, on the other hand, makes a single coil of one turn and a half from its outer end, and thus forms a contrast with the double coil in each dorsal. The small gut lies in the centre, fixed by the ordinary mesenteries. The ventral groove is now open and the ventral hypoderm is considerably thinner.

Euchone would thus appear to show a more primitive type than *Chone*, since anteriorly the dorsal and ventral longitudinal muscles have a simple loop, after the manner of *Nereis*, whereas posteriorly the coiled type of muscle has made its appearance. It is also in contrast with *Dialychone* of Claparède, in which the coiled muscles begin at the anterior end.

2. *On some Points in the Structure of the* Serpulidæ, *chiefly of* Pomatocerus triqueter, *L.*

Less was accomplished in the minute structure of the Serpulids than in the Sabellids until Claparède took up the subject in his 'Recherches sur la structure des Annélides Sédentaires'*. He dealt in this group for the most part with *Protula intestinum*, in which he found the hypoderm greatly developed on the ventral surface and richly vascular. In *P. infundibulum* he noted the pennate arrangement of the longitudinal muscles in section, and pointed out that the intestinal sinus is lodged between the epithelial coat and the circular muscular fibres, and that giant fibres occur in its great nerve-cord and œsophageal commissures. He thought that in *Psygmobranchus protensus* the distant halves of the ganglionic cord denoted inferiority, especially as in larval annelids this condition is more marked than in the adult. Three pairs of ganglia occur in the thoracic region, the largest being the second, and they are united by transverse commissures. He stated that in the Serpulids only a single pair of segmental organs occured, viz., in the thorax, and that they gave exit to the reproductive elements. In his description and figures the voluminous folds of the organ are indicated, and he considered that, by filling up the body-cavity, they conduced to the solidity of the region.

Schenk† (1874) gave a brief account of the structure of the body-wall in *Serpula uncinata*. In his transverse sections he appears to have overlooked the great nerve-trunks, though traces of these occur in his figures.

* Posthumously published in 1873.

† Sitzb. K. Akad. Wiss. Wien, Bd. lxx. pp. 1, 2, pl. i.

Eugen Lee* (1912) describes the blood-vessels and sinuses in *Protula*, *Vermilia*, and other Serpulids:—The main channels, he states, are determined by the metamerization and differentiation of mesodermic bands which arise from pole-cells. The gaps between the splanchnopleure and intestinal epithelium, or between the neural and hæmal mesenteries and septa, give rise to channels for the nutrient fluid diffusing through the epithelium of the gut. The channels at first have no proper walls. The walls of the visceral sinus and dorsal and ventral vessels are due to muscular differentiation of the splanchnopleure The lumen of other blood-channels is interseptal and closed off by peritoneal walls from the cœlom.

As indicated in the remarks on *Bispira*, E. Meyer has devoted much attention to the structure of the Serpulids, which he contrasted chiefly with the Hermellidæ. He also followed the development of the thoracic nephridia in *Psygmobranchus protensus*, and went minutely into the processes and collar of the anterior region. His observations on the various organs, though somewhat diffuse, are of much interest. The Sabellids were included with the Eriographidiidæ and Serpulidæ under his Serpulidæ.

A prominent feature in the anterior body-wall of *Protula tubularia*, Mont., is the great size of the dorsal longitudinal muscles, thus agreeing with *Pomatoceros*. The cuticle and hypoderm are well developed throughout, whilst on the ventral region anteriorly is a thick glandular investment with numerous small blood-vessels at its inner edge, a condition probably associated with a special secretion. In order to follow the arrangement of the muscle it is necessary to examine the extreme anterior end, where the dorsal surface has a deep groove in the middle line, the rounded parts on each side indicating the projecting dorsal muscles, which already are large. The lateral regions are formed by extensions of the body-wall, and bear the bristles in each segment. A thin circular coat lies under the hypoderm external to the dorsal longitudinal muscles, and it extends into the lateral regions. Sections of the posterior end of the ganglia lie below the great muscles, and in the mid-ventral line is an elongated area between them. The alimentary canal is clasped by strong circular muscular fibres, the circular muscular coat of the body-wall being external to it. In the middle line numerous vertical fibres pass

* Jen. Zeitsch. Natur. xlviii. pp. 432–78, with 6 plates.

from the alimentary canal to the mid-dorsal groove, and they by-and-by separate the nervous masses on each side. A projecting process, probably glandular, occurs on each side of the middle line ventrally, and the hypoderm is specially thickened toward its exterior. At the outer edge of the space lying below and external to the great dorsal muscle on each side is a muscular band, but such is distinct from the ventral longitudinal muscles which in section appear as small rounded areas on each side of the middle line, and with the nerve-trunks and the great neural canals at their inner borders. Proceeding backward the ventral longitudinal muscles gradually separate from each other and become flattened in section, thus carrying the nerve-trunks further from the middle line, the ventral blood-vessel lying in the centre with the alimentary canal above it grasped between the massive dorsal longitudinal muscles. In the long space between the ventral muscles and the nerve-cords are several small fascicules of longitudinal muscular fibres, and large processes of the alimentary canal appear above the inner edges of the ventral longitudinal muscles. The vascularity of the inner region of the hypoderm is noteworthy. Further backward the œsophageal region diminishes, whilst a process of the gut appears above it, and the two processes beneath the œsophageal chamber have moved inward toward the ventral blood-vessel, whilst the dorsal longitudinal muscles are somewhat further apart. The ventral longitudinal muscles are larger and are elongate-ovoid in transverse section with the nerve-cords at their inner edges. They are separated by the processes of the gut and the ventral blood-vessel.

In the posterior region a change has taken place in the structure of the body-wall. The dorsal longitudinal muscles have now spread out into thick plates on each side of the middle line, and in the lateral region end in a massive rounded area of folded muscular fasciculi, which in section show a pectinate or feathered aspect. A large alimentary canal occupies the centre. The ventral longitudinal muscles are still proportionally small, forming, in section, elongated plates somewhat thicker externally, and with the nerve-cords and their large neural canals at the inner edge. They are separated from each other by the ventral blood-vessel, which is in contact with the gut superiorly. The inner edges of the ventral muscles have thus moved nearer the middle line. The ventral hypoderm now presents the same structure as the dorsal.

The hypoderm in *Serpula vermicularis* is firmer than in

Protula, and anteriorly the ventral hypoderm is non-vascular. Within is the circular coat which extends all round, and presents special developments at the foot. The dorsal longitudinal muscles form massive kidney-shaped lobes in transverse section, separated in the mid-dorsal line by the alimentary canal and its short mesentery and by a vessel at each side. These muscles extend from the dorsal almost to the ventral edge, and are proportionally larger than in *Protula*. On the other hand, the ventral longitudinal are smaller, and in section are short spindle-shaped bands widely separated from each other, and with the nerve-cord and its large neural-canal at the inner edge. Between the latter stretches a thin but continuous layer of longitudinal fibres, having the circular muscular coat externally and the ventral blood-vessel internally, with the muscular aponeurosis on each side, as well as certain fibres from the slender oblique, which passes the cord and is attached over the thin muscular layer. The alimentary canal has a thick investment of circular muscular fibres with groups of inner longitudinal and a richly folded mucous lining. It stretches from the dorsal surface to the ventral blood-vessel. The dorsal fold arising from the foot is hollow distally.

An interesting feature is the presence of a peri-intestinal sinus in the outer wall of the alimentary canal and extending from the posterior region forward to the œsophagus, and which takes the place of the dorsal vessel of other forms, and the same arrangement occurs in the Ariciidæ, Chætopteridæ, Ammocharidæ, Sabellidæ *, and other families.

The peri-intestinal sinus surrounds the canal throughout the greater part of its extent, and in *Eupomatus elegans* Prof. Haswell states that the sinus ends in front of the œsophageal region in a short wide dorsal sinus or cardiac sac, from which a pair of vessels pass to each branchial base, "where it (each) unites with a smaller branch from the ventral vessel to form the common branchial vessel," which makes a curve—giving off a branch to each branchia and the operculum and pseudo-operculum. "The ventral vessel is a distinct wide trunk, which is continued along the body, and in front communicates with the branches from the dorsal sinus. The capillaries of the collar and flaps receive blood from the ventral vessel, and, as in the branchiæ, the circulation is to-and-fro." The blood which enters the peri-intestinal sinus by the segmental vessels is carried forward

* Haswell, Proc. Linn. Soc. N.S.W. vol. ix. pp. 1–27 (sep. copy).

by peristaltic contractions to the cardiac sac, whence it is driven at intervals forward to the common branchial vessels and by the separate trunks to the tips of the branchiæ. It returns by the same course and enters the lateral ventral trunks, and passes to the ventral vessel, by which it is distributed to the collar and the body generally" (*Haswell*). In *Pomatoceros* the abdominal region possesses the peri-intestinal vessel and a minute ventral trunk. Anteriorly the former splits into a large dorsal vessel or cardiac sac and about 16 smaller vessels, which run on the wall of the alimentary canal. Further forward the peri-intestinal vessels join the dorsal trunk, thus making two main trunks, a large dorsal and a small ventral. Then the dorsal bifurcates into the two branchial, and so does the ventral, but Prof. Haswell was uncertain whether the latter communicated with the former as in *Eupomatus*. All the vessels possess a muscular wall, and the blood in the majority is of a light green colour, and contains certain clear oval bodies probably derived from the epithelial lining of the vessels.

A pair of thoracic glands exist in this group as in the Sabellidæ. In *Eupomatus* and *Serpula* each has the form of a brown body with its long axis directed longitudinally, the posterior part with thinner clearer walls and an anterior dark brown folded part. No opening into the cœlom was made out by Prof. Haswell. In front the gland is continued into the ciliated duct, which passes almost directly inward to meet its fellow in the middle line, the common duct going straight forward to open ventrally (dorsally) between the bases of the branchiæ. The gland is lined by large, granular, nucleated cells, each furnished with a flagellum at its apex. Haswell found the "true" segmental organs in all the abdominal segments, viz., delicate pyriform sacs ciliated internally, and opening externally on the sides of the segments by slit-like apertures having active cilia. No internal aperture could be made out. In *Eupomatus* each in the female contained a group of ova at various stages up to the fully developed egg. These segmental organs alternated with the ovaries. In the males these sacs were always empty.

No feature is more distinctive of the Serpulids in contrast with the Sabellids than the extreme transparency, thinness, and minute serrations o the hooks. As a rule, they approach in shape those of the Ampharetidæ rather than those of the Sabellidæ. The hard, smooth, calcareous nature of the tube probably necessitates a special adaptation of a mobile torus with flexible hooks, the free edge of which is beset with a

multitude of minute processes—probably of great use in fixation. Another structural characteristic is that of the first or collar bristles, which, for example, in the Spirorbids are of specific importance. The absence of tentacles (two of which are present in the Sabellids) and the presence of a calcareous operculum in the Serpulids are distinctive, just as the long branchiæ of the Sabellids are in contrast with the shorter organs in the Serpulids.

The secretion of the tube, as indicated under *Pomatocerus triqueter*, takes place with considerable rapidity—for instance, on the carapace of the shore-crab, on porcelain or stone-vessels and bottles thrown into the sea, and is further proved by observations in confinement. Mr. Arnold Watson thinks it is secreted by the outer side of the collar, since, as soon as the anterior part of the annelid emerges, the collar is folded over the edge of its tube, its two lobes meeting over the mucro. He adds, however, that the formation of a diaphragm in a broken tube shows that other parts may likewise secrete the calcareous matter. As detailed in the structure of the hypoderm, the collar and the free surfaces of the thoracic jacket contain much glandular tissue, as likewise do the lamellæ or elevations for the tori uncinigeri.

Hypoderm.—In the anterior sections of the body-wall of *Pomatocerus triqueter* the dorsal is distinguished from the ventral hypoderm by the intensity of the stain (Ehrlich's Hæmatoxylin and Eosin) * in the latter, viz., from the slight projection below the enlarged base of the dorsal flap or process to that of the opposite side, the glandular tissue, like that of the œsophageal wall, readily absorbing this stain, so much so as to become opaque. The dorsal hypoderm, on the other hand, has only the nuclei tinted near its outer edge, and the inner part of the enlarged base of the dorsal flap shows likewise glandular tissue. The thoracic collar anteriorly (Pl. IV. fig. 21) is somewhat complex in *Pomatocerus triqueter*, having dorsally a large fan-shaped lamella on each side, then a gap between it and the continuous ventral portion of the collar, whilst a small lamella with processes on the edge occurs at the gap, its base having a closer connection with the ventral than the dorsal moiety. This condition of the ventral hypoderm continues backward to the end of the thoracic glands, the lateral processes bearing the hooks being especially glandular. Then the glandular

* I am indebted to Miss Lamont, of the Zoological Department of Edinburgh University, for aid in section-making, my own trained men being on service.

tissue forms a patch on each side of the middle line ventrally, as well as on the edges of the ventro-lateral processes, and thus these form a contrast with the dorsal (branchial) processes. Thereafter (proceeding backward) the glandular tissue is almost absent from the median ventral region, but is highly developed on the ventro-lateral processes; soon, however, it again appears in the ventral plate or fillet, which has glands along its lower edge, a few remaining in the hypoderm of the ventral surface of the body-wall.

So long as the free flap of the thoracic jacket or collar occurs, the glandular tissue in the hypoderm of the ventral edge of the flap is dotted at intervals with glands, and they are also distributed along the ventral hypoderm of the body-wall, but in moderate numbers. As the flap diminishes the ventral median groove of the body-wall becomes deeper, but its hypoderm is thinner than that at the sides (beneath the ventral longitudinal muscles), the glands, however, being continued in it. When the jacket ends, the hypoderm generally is somewhat thinner, the ventral groove rather more shallow, and the glands are but slightly developed, the most conspicuous aggregations being in the lateral thickenings bearing the hooks, so that the region is in marked contrast with the anterior. This description applies to the body-wall as far backward as the valvular region of the alimentary canal.

In the posterior division of the body the glands still occur in the lateral region and on the lamellæ for the hooks, as well as a few along the ventral border, especially on each side of the ventral groove. Very few occur dorsally—indeed, in most sections they are absent form the dorsal arch, only nuclei occurring there.

The hypoderm at the level of the origin of the opercular stalk (Pl. IV. fig. 20) often presents a fan-like arrangement of its long cells, as at *hpe.*, a condition probably due to slight folds in the sections, but such recalls the aspect of some simple sense-organs, *e. g.* eyes, though no pigment is present, only the stout basement-tissue on which the cells rest. That this modified hypoderm in the anterior region performs special functions is evident by contrasting the outer and inner surfaces of the thoracic collar or jacket, also by the massive thickness of some parts, the thinness of others, and the blanks in the layer only invested by cuticle (*hb.*) in the same figure. The almost perfect regularity of the nuclei and the fibroid aspect of the long cells are other features of moment. The blanks (*hb.*) in the hypodermic coating consist of a reticulum of nucleated cells supported internally

by strands of basement-tissue, whilst externally is the cuticle and within it a very thin extension of the hypoderm from each side, only of sufficient depth to contain the abbreviated nuclei continued in close array along it. The general aspect of the reticulum agrees with that found in the central area of the differentiating opercular stalk, and is in contrast with the modified hypoderm above-mentioned.

Thoracic Glands.—In the fresh example two brownish bands lie on each side in front, pointed behind, and increasing in diameter as they go forward. A wide duct from each passes inward, apparently with a slight forward obliquity, to meet its fellow of the opposite side, and then by a common median duct to open dorsally between the bases of the branchiæ. The lateral ducts show large brownish granular glands similar to those lining the interior of the glands proper, but they do not pass forward from the point of junction of those of opposite sides.

The glands in the anterior region of *Pomatocerus triqueter* are first noticeable in transverse sections from the front as somewhat irregular spaces due to folds, for this is their widest region, shortly after the ventral cords leave the brain, and in the lateral region to the upper and outer side of the nerve-trunks. The early stages do not present so definite a cellular lining as subsequently forms, though the cells are present, with processes, apparently of cilia, extending inward from their free edges. Surrounding the cellular lining is a layer of connective tissue with numerous nuclei. The spaces soon unite (proceeding backward) into a large cavity lined with cubical cells, and stretching from the nerve-cord obliquely upward and outward to the bristle-tuft (Pl. V. fig. 26, *ty.*), the processes still projecting from the inner surface of the cellular lining (the flagella mentioned by Prof. Haswell). Externally is a compact cellular mass, *cm.*, with distinct nuclei, and this, from the contraction of the lumen of the organ and its passage toward the ventral aspect, gets above the cavity—touching the basement-membrane of the body-wall. The latter in this region has the comparatively small dorsal muscles separated by a gap, in the middle of which is the mesentery holding the dorsal blood-vessel and the alimentary canal below it. A considerable band of longitudinal muscle (Pl. V. fig. 26, $m.^1$) lies dorsad of the two masses of the dorsal longitudinal, and separated from them by septa. A thin band of longitudinal muscular fibres stretches on each side a short distance to the inner side of the nerve-cord. As the thoracic gland diminishes, its cubical cells and their large nuclei become clearer, the processes still

project from their inner edges, and the duct lies to the ventral or inner edge of the tori and the bristles. When the tube has about 18 cells in its wall (and is therefore small) the glandular or dorso-lateral appendix, *cm.*, is fully twice its diameter, and soon the tube vanishes, leaving only the thin glandular belt within the body-wall. This dorso-lateral appendix appears to be somewhat akin to the multinucleated cœlomic bodies described by Prof. Caullery * in *Eunice harassii*, Aud. & Ed. As already mentioned, the ducts from the anterior end show flask-shaped brown granular glands, but the single duct formed by their union is quite pale.

Toward the termination of the thoracic glands, and behind them, the cœlomic cavity contains vessels and chloragogenous tissue covered with opaque granular masses, often enveloped in the chloragogenous sheaths. These continue for some distance backward and by-and-by disappear.

Whilst the thoracic glands are still of moderate size—that is, toward their posterior third,—it is noticeable that they are bounded externally by a firm layer of the body-wall ending inferiorly in a free process, which in transverse section is clavate (Pl. V. fig. 28, *p.*). This layer, *ab.*, has rather regularly arranged fibres at right angles to the axis of the body, which stain like the muscles in their neighbourhood, and do not resemble the hypodermic nucleated cells. It has externally the pad or process bearing the hooks, and it terminates ventrally, rather past the middle of the section of the thoracic gland with its appendix, in the free process, the ventral end being pale. The narrow bar, however, proceeding forward, soon enlarges into a thicker layer of prism-like cells with the nuclei at their free surface, thus giving the aspect of a series of punctures at the enlarged outer ends, for the cells, *ce.*, are clavate and minutely granular (Pl. V. fig. 29). This peculiar cellular layer runs upward on the external border of the branchial stalk, the inner layer, continuous with the dorsal hypoderm, presenting quite a different structure, and the nuclei are within their superficial ends (Pl. V. fig. 29). The function of this special cellular development would seem to be in connection with the well-developed hook-pads of the region rather than with the thoracic glands, probably acting as an elastic cushion. The muscular fibres seen in Pl. V. fig. 28, *m.*, are those which move the hook-pad, whilst that structure itself is largely composed of the modified hypodermic cells just described. Hence the appearances of the parts vary

according to the line of section. Thereafter, the tissue gradually merges into the hook-pad with its superficially arranged glands, and so on throughout the region, the inner or secondary ridge appearing and disappearing in each segment.

The supporting tissue in the anterior region of *Pomatoceros triqueter* differs from that in the Sabellids. Just as the nerve-cords leave the cephalic ganglia, and whilst still connected by a long and strong commissure, no special supporting tissue is visible. The long, narrow, hypodermic cells of the dorsal wall (Pl. IV. fig. 20, *hpe.*) are indeed of great depth, especially in the middle line, so that when torn they resemble fibres, whilst within the basement membrane are only the thin circular muscular fibres and the dorsal longitudinal muscles—as yet little developed. As the opercular stalk leaves the body-wall of the region (Pl. IV. fig. 20, *op.*) its central areolar mass joins the other tissues and may stiffen the parts, for as yet the fibres of the dorsal longitudinal muscles are few. Through this mass a bifid nerve-trunk from the cephalic ganglia passes. The remarkable thickness and the appearances of the hypoderm of the region in this species would suggest the view that it may more or less be connected with the function of the special chordoid skeleton of other forms. In this respect the dorsal differs essentially from the ventral hypoderm of the region, which is richly glandular. The muscular tissue at the base of the stalk is reticulated in longitudinal section, as if the sarcolemma formed a network; indeed, reticulation of the muscular fibres themselves would appear to occur, though the trend of most at the base of the stalk is longitudinal.

The projection of the opercular stalk causes asymmetry of the body-wall and of the incipient dorsal longitudinal muscles, for the muscle of the same side considerably increases in size, probably in relation to the movements of the stalk. The body-wall remains asymmetrical after the stalk separates, that side being less than the opposite one, in which, moreover, the slits separating the branchiæ first appear. This asymmetry subsequently disappears in front when the filaments approach separation, but it is a marked feature. Connective-tissue cells fill up the lateral space within the body-wall beyond the region of the cephalic ganglia, but these do not show special chordoid structure. Deeply stained nerve-cells surround the cords and the transverse fibres between them. The enlarged base of each ventral flap of the thoracic jacket has connective-tissue cells similar to those in the lateral region of the body, the flap

being joined to the body-wall by a firm isthmus in the middle line, its two surfaces beyond being structurally differentiated, the inner (that is, next the body-wall) being coated by a thick layer of the long hypodermic cells with the nuclei near the surface, whilst the outer has much shorter cells, the inner ends of which seem to run into the reticulated connective-tissue of the central region. Masses of gland-cells, moreover, occur along the convex margin of the jacket. In the area of the cephalic ganglia the modified hypoderm is thickened in the mid-dorsal line and also laterally so as to form a protection to the organs. Then on the side (generally the left) from which the opercular stalk springs this modified hypoderm bulges out and envelops it (Pl. IV. fig. 20). Further, the glandular nature of the ventral wall diminishes, and a split separating the jacket or collar appears and joins the folded lateral and dorsal flaps, both the inner surface of the collar and the outer of the body-wall being invested by layers of the hypoderm. As soon as the collar becomes free (in section) the entire body-wall, with the exception of a narrow lateral belt on each side, is invested by this modified hypoderm, the thickest parts being the dorso-lateral and mid-dorsal regions; and the origin of the opercular stalk has the same investment, special support being afforded by the adjoining mid-dorsal and lateral enlargements of this modified hypoderm. Proceeding forward the ventro-lateral regions of this coat are considerably thickened, and a deep furrow now cuts off the opercular stalk (Pl. IV. fig. 22). The diminished area of the anterior region is specially stiffened, for in section the greater part of its surface is composed of this modified hypoderm, the only gaps being those of the mouth, the branchial trunks, and a cœlomic space. The shape in section is that of a curved dumb-bell (Pl. IV. fig. 23), the narrow median region with the oval slit corresponding to the handle and the enlarged lateral regions to the bells. Instead of the dorsal region having the thick layer of modified hypoderm, it is now the ventral surface, and the band is dilated at each side, after which is a connective-tissue belt, then a band of the modified hypoderm round the bulbous ends, in which by-and-by appear the slits indicating the separation of the branchial filaments. These slits have a regularly arranged cellular investment with distinct nuclei, and they increase in size and number from behind forward. The intermediate region, between the dilated ends of the dumb-bell, has only a thin coating of ordinary hypoderm, and is thus in contrast with the lateral regions. Advancing forward a slit appears

on each side of the vestibule, and thus the enlarged ends of the dumb-bell are more distinctly differentiated from the curved median region with its widening vestibule (Pl. IV. fig. 23). At this level there are four intermediate branchial slits, and the inner on each side is the more elongated, whilst the conical ventral edge of the lateral enlargement is stiffened by a cap of the modified hypodermic tissue. The ventral collar (jacket) has now much diminished in size, but the dorsal edge of the organ still shows a coating of the modified hypoderm. Further forward the collar forms but a small U, the thick layer of its hypoderm being, as formerly, dorsal; the median lamella containing the vestibule is longer, whilst the dilated ends are somewhat crescentic and show six intermediate slits. The ventral edge still has the thickest cap of modified hypoderm. The vestibule has now expanded laterally into a wide space at the base of the branchiæ, and there are seven intermediate slits, the largest being dorsal and the smallest ventral in position. Advancing forward, or distally, the slits increase to nine, and the outer margin of the dilated ends becomes frilled as the filaments differentiate, the dorsal, where the largest slits are, soon presenting filaments connected only as their outer border, the free inner edge being deeply grooved (bifid in section) (Pl. II. fig. 12). The outer border of each filament has the tough cuticle with the hypoderm beneath, in which is a nerve, and joining in the centre a connective-tissue area which runs inward to the free grooved edge, whilst the sides are strengthened by the modified hypoderm, especially externally, for it tapers internally. Each of the laminæ forming the groove has a blood-vessel in its centre (Pl. III. figs. 18 & 19), and branches by-and-by enter the pinnules. Proceeding still further distally, the curve in each fan is larger, and the dorsal filaments, which have become rounder and their hypoderm more glandular, show longer connecting bands, and finally separate, the isolated ones having slightly shallower grooves than the fixed, whilst their radial diameter diminishes and their transverse increases proportionally.

The filaments gradually taper distally, the edges of the groove break into pinnæ (Pl. IV. fig. 25), and the modified hypoderm forms three distinct external divisions, whilst in the centre is the connective-tissue area with its blood-vessel, a vessel occurring also in each pinna. Besides the central blood-vessel there are two conspicuous channels slightly to the exterior on each side, and these probably communicate with the cœlom. In longitudinal sections of the filaments the centre shows a distinctly chordoid structure

not always easily observed, and this is apparently due to the cells of the hypoderm or to a supporting tissue within it, the former interpretation being the more likely, as no differentiation is observed in transverse section.

Diverse views have been held with regard to the structure of the filaments and pinnules; thus Meyer described a diverticulum of the cœlom in each filament and pinnule, whilst Orley insisted that only connective tissue occupied the centre. It is by no means easy to decide, since in the case of sections the parts are considerably altered even in good preparations. A cœlomic space occurs on both sides at the level of the dumbbell-shaped region in front of the brain (Pl. IV. figs. 20 & 21, *cœ.*), and their walls are defined by connective-tissue, and probably muscular, fibres, the area surrounding them consisting of nucleated connective-tissue cells. About this level the thoracic jacket or collar has just become free or is only connected by a narrow isthmus. As a rule, also, the two sides are asymmetrical in section, the opercular half having no slits, but a considerable cœlomic space, whilst the other side has only small apertures, so that the area within (that is, ventral to) the slits is reticulated, these reticulations in the succeeding sections becoming less and less until only the branchial vessel is evident. The epithelium surrounding the slits becomes regularly arranged and forms the hypoderm and cuticle of the filaments, each side being attached to a separate filament. The elongated centre of each filament in formation is almost wholly occupied by nucleated connective tissue with the blood-vessel in the centre, but two splits, one on each side of the mesentery, are often seen at the distal end of the central area, occasional strands of tissue crossing the spaces in some sections. The definite median mesentery with its central blood-vessel and the definite cœlomic spaces at each side, and from end to end in transverse section of a pinnule, as shown by Soulier in *Protula milhaui*, have not been observed either in filament or pinnule. In longitudinal sections of a filament, the sides are formed of cylindrical nucleated epithelium, whilst the centre is almost filled with nucleated connective-tissue cells, a narrow split at one or other side being present, and even this has a few strands with nuclei. The pinnules of this form (*Pomatoceros*) show only a central cavity in which the blood-vessel is (Pl. IV. fig. 24), but the cœlomic fluid could readily rush to and fro in the space around it, whether a special mesentery fixes it or not. On the whole, therefore, the view that the cœlomic spaces—carried forward to the splits for the commencing branchial filaments—do not blindly end there, but communicate with the filaments and

pinnules, would seem to correspond with the appearances. The branchial apparatus of such forms would thus in their movements appear to have not only muscular aid, but the important influence of the cœlomic fluid, so that the ciliary action of the pinnules and filaments would materially aid respiration as well as conduce to alimentation.

Opercular Stalk.—The opercular stalk arises as a process of the basal region of the branchial apparatus immediately in front of the brain, the tissues of one side gradually projecting (Pl. IV. fig. 20), then being nipped off as an independent process surrounded by the cuticle, the modified hypoderm as a considerable coat all round, and a central area more or less muscular at first, with numerous nuclei. The base of the organ occupies at first more than half the dorsal outline, but, as it separates and the median fissure deepens, the other side increases in bulk. The external fold of the cuticle bends inward, the hypodermic cells curving round the central area (Pl. IV. fig. 22) and soon the stalk is free. Its outline in section is somewhat rhomboidal, and much smaller than it is distally. At this level the thoracic jacket or collar is fixed by a broad isthmus to the region below the gullet. Then the stalk becomes conical in section, and the blood-vessel in the centre of the muscular tissue more distinct, whilst the modified hypoderm, which is almost fibroid in section, maintains nearly an equal thickness all round. The base of the cone—that is, the dorsal edge—by-and-by lengthens by a transverse projection at each side, so that it resembles a cocked hat in section (Pl. VI. fig. 32), the projecting edges having the thickest hypoderm from the approximation of the two layers separated by a line, the central pseudo-chordoid and muscular areas with the vessel remaining as before. The opercular stalk at this level is flattened externally or dorsally, convex ventrally, and its cuticle is dense. A differentiation of the central region now takes place, for the outer or dorsal edge of the hypoderm becomes thinner, and an elongate-ovoid and apparently muscular area stretches from lateral projection to lateral projection, a groove in which the blood vessel lies (Pl. V. fig. 30) occurring ventrally. The muscular fibres seem to pass to the calcareous region of the operculum—namely, to the tip of the stalk. They are well developed in the region of the lateral ridges. The appearance of the parts seems to vary considerably in sections of different examples, a feature due perhaps to recently reproduced organs (*cf.* Pl. VI. figs. 32 & 33) and to obliquity in section, for in some cases (Pl. VI. fig. 33) muscle and pseudo-chordoid tissue are both present. The reticulations of the next (more distal) area are larger and

better defined than the pseudo-chordoid tissue which occupies the convex region ventrally (Pl. VI. fig. 33). The chordoid axis soon increases in bulk, and fills the stalk except the thin hypodermic region and a stripe of pseudo-chordoid tissue, still with its blood-vessel ventrally, the cuticle enveloping all. The basement-tissue is slightly developed in the ventral arch, but forms a well-marked layer dorsally, fusing with the tough issue in the middle of the stalk, but being better differentiated at the base of each external ridge, a thin line of it running almost to the tip of the latter. The section of a nerve (Pl. VI. fig. 32, *n*.) occurs at each outer angle and in the middle of the dorsal arch, the former being outside the basement-tissue, the latter within it. In the basal (proximal) or incipient condition of the stalk this basement-tissue is less developed than distally, and the relationships of the nerve therefore undergo changes. The groove for the larger blood-vessel in some preparations sinks more deeply into the chordoid tissue. The projecting ends of the ovoid area of the opercular stalk assume a clavate outline and then disappear—that is to say, the ridge on each side of the stalk ceases after the lateral filaments of the stalk have separated. With the disappearance of the lateral ridges the chordoid tissue occupies in section the entire area of the ovoid stalk, only a thin, barely visible, belt of hypoderm occurring under the cuticle. In some of the sections the strands of the chordoid tissue are arranged in a somewhat radiate manner with the nuclei and cut ends of fibres at the circumference, so that, when the hypoderm and the cuticle are shed, such might be mistaken for the modified hypoderm. Further, the blood-vessel is now enveloped by the chordoid tissue. Soon a differentiation in the midst of this area appears as a smooth central region from which lines radiate to the external margin. This central region gradually increases distally, and the differentiation of the radiating cells with the nuclei externally gives it, in some preparations, the appearance of a hypoderm within a hypoderm as just mentioned; and, moreover, a ridge or papilla appears on one side of the actual cuticle or hypoderm. The blood-channel is enclosed in the inner area, and is large. The ventral hypoderm and cuticle diminish and disappear, leaving what was the chordoid area and its central region, with the addition of a small patch, isolated in cuticle, to represent the former envelope of the stalk, and that soon vanishes. Thus the enlarged opercular stalk now consists of the tough cuticle, the modified coating of the chordoid area representing the hypoderm, with its

nuclei externally and a large pale area, probably chordoid, with a well-defined ovoid outline, in the centre of which is the blood-vessel. Muscular fibres would thus act on the base and up the stalk of the operculum, whilst its rigid tissues distally are fitted to perform the part of a plug to the calcareous tube. Beyond the lateral subulate processes the distal region of the decalcified operculum presents externally a tough cuticular investment, then a layer of long hypodermic cells with the nuclei near the external border, the central area being occupied by a tough nucleated plasma with small spaces near the external margin, where a thin basement-tissue bounds the hypoderm.

In vertical section the decalcified operculum has on its convex side the thick cuticle very dense at the rim, then a deep layer of long narrow granular cells, a thin connective-tissue or chordoid centre, and on the concave surface (anterior) a narrow belt of reticulated tissue, and externally a cuticular coat about twice the thickness of that on the convex side. When viewed externally the distal (calcareous) region of the operculum presents a minutely reticulated condition all over (after decalcification).

It has generally been held that the operculum is developed on a modified branchial filament, and hence the occasional occurrence of one on each side, or the facility with which a new organ is produced on the right when the other is lost. Without calling this view in question, the foregoing account shows that about half the area of the body-wall behind the branchial base is concerned in the production of the operculum with its special differentiation of tissues, and that the development of the branchial filaments occurs in front, under different conditions, and rather in association with the vestibule and mouth than with the protective, or it may be in certain cases the reproductive, functions of the operculum. The appearance of the inter-filamentar slits after the formation and separation of the opercular stalk point to a wide divergence both of structure and function, though it may be argued that these radical differences may have been evolved slowly in the history of the race. Yet eye-specks or more complex visual organs are never found on the opercula, while they are not infrequent on the branchial filaments; just as calcareous or other hard structures belong to the opercula, for the soft cellular thickenings of the tips of the branchial filaments, which characterize certain varieties of *Filograna*, and which some have supposed to perform opercular functions, can scarcely be placed in this category. Moreover, in some groups the opercula are very variable,

and may be present or absent, as in *Filograno*, with perplexing indifference, whilst in other forms their stability and characteristic shape have made them of specific importance. It is interesting in connection with the branchial view of the opercular stalk that transverse bars of bluish pigment are occasionally seen on it.

Muscular System.—Immediately behind the brain muscular bands pass from the sides of the ventral to the dorsal wall (or *vice versâ*), some of the same side being attached to the base of the opercular stalk dorsally—indeed, they seem to be strongest and best developed at first on that side. Ventrally they are inserted on each side of the nerve-cord, and by-and-by they bound the thoracic glandular organ on its inner border.

Behind the ganglia and the opercular stalk the body-wall assumes a more symmetrical outline, and the dorsal longitudinal muscles become more distinct and quite separate from each other, but the ventral longitudinal muscles are indistinguishable. In the median ventral region, however, a special thin longitudinal muscular band occurs on each side, and continues backward a short distance—disappearing as the actual ventral longitudinal muscles become distinct. These ventral longitudinal muscles are formed by fibres on the lateral region of the body-wall outside the anterior glandular organ and its appendix, and not in contact with the nerve-cords, which are separated from them by a considerable interval. Their outline in transverse section is elliptical, and, as the glandular organ in its progress backward diminishes, the fibres seem to pass externally; then, as the glandular tube disappears they form a thin stratum to the outer side of the nerve-trunks and in contact with them, the anterior median ventral fibres being still visible between the nerve-trunks. By-and-by the median, or pseudo-ventral, or anterior ventral, fibres (Pl. V. fig. 26, *m*.²) disappear from the middle line, and the ventral longitudinal form a spindle-shaped layer in section, separated by an interval from the dorsal, which bend inward at their lower ends, whereas the ventral pass outward below and beyond them. The dorsal and the ventral longitudinal muscles, however, by-and-by fall into line and the body-wall becomes more compact, the dorsal muscles retaining the great preponderance in bulk, and closely approximated to the ventral, only a slight incurvation of the inner surface and traces of the oblique muscle indicating the line of separation; yet the distinctly pennate arrangement of the fasciculi of the dorsal is characteristic. The nerve-cords are more

closely approximated than in front, but are still separated by a considerable interval. The body behind the foregoing region of the thorax becomes rounded in transverse section, a large area being occupied by the dorsal longitudinal muscles, which cover nearly two-thirds of the circumference (Pl. V. fig. 27), and form a broad belt in section, only slightly narrowed as it approaches the mid-dorsal line, where no distinct hiatus occurs, the whole forming a hoof-shaped belt. The ventral longitudinal muscles, on the other hand, form two spindle-shaped areas, now also with pennate fasciculi, separated by the median space containing the central blood-vessel. This disproportion of the dorsal longitudinal muscles continues to the posterior end, though in relation to the diminished area of the body-wall both sets of muscles are more bulky; whilst the thinning of the dorsal muscles toward the middle line is scarcely evident.

The dorsal longitudinal muscles, though comparatively small, are formed in front of the cephalic ganglia, and at the ganglia they show two lateral enlargements connected by a median band of fibres to which the dorsal vessel is attached. Behind the ganglia the connecting band of fibres is shorter (in transverse section), whilst the lateral enlargements are gradually increasing. These muscles do not at this part reach the lateral regions of the body, but lie in a special cavity invested by membrane on each side of the median dorsal vessel, the direction of the lateral masses being nearly vertical, since to their exterior is the dilated anterior end of the thoracic glands. Proceeding backward, the first change noticeable is an increase of the nucleated connective tissue in the median belt and its continuation between it and the enlarged lateral regions until each of the latter is separated, so that it lies in a membranous chamber of its own, the spindle-shaped median belt being characterized by its numerous connective-tissue nuclei. Moreover, the direction of the muscular fibres of this median band seem to differ, since they are obliquely cut in the sections. Each dorsal longitudinal lies in its sheath in this region, with the vertical bands of muscle and the dilated cavity of the thoracic gland to its exterior, the long diameter of the mass being still nearly vertical. Then, instead of being spindle-shaped, the median band of muscle is divided into two by a central dimple to which the mesentery from the dorsal vessel is attached. This separation of the two halves increases until there is a clear space between them, the median mesentery now being fixed to the basement-tissue inside the hypoderm, the separated portions of the muscles lying closely over

the larger masses beneath them, and they soon fuse with them, meanwhile this wide space dorsally intervening. The diminution of the cavity of the thoracic gland on each side permits the muscles to assume a more oblique position, so that their axis in section is directed downward and outward. On the disappearance of the thoracic glands (in the progress backward) the muscles more closely approach each other in the mid-dorsal line, the upper as well as the lower ends being pointed in section. Then a tendency for the lower ends to bend inward is noticeable, the investing mesentery being still visible externally, whilst the muscles have likewise considerably increased in bulk. This divided condition of the dorsal longitudinal muscles characterizes the anterior region of the body, for toward the middle there is complete union of the halves (Pl. V. fig. 27), and the entire muscle has greatly increased in size, forming a broad crescent which reaches by its expanded inferior edges almost to the ventral surface. No distinct trace of a mid-dorsal fissure is seen, the median mesentery being attached to a slight muscular ridge at its inner surface.

Alimentary Canal.—The various ciliated grooves from the branchial apparatus to the mouth converge to the double isthmus connecting the two fans, and which in the sections is usually V-shaped, the apex being directed ventrally (Pl. IV. fig. 23), the upper layer being pierced by a blood-vessel at each end. Then, proceeding backward, the V expands into a curve, the ventral isthmus receives a coating of hypoderm, both isthmuses becoming shorter and thicker, with a slit at either end opening by-and-by to the dorsal surface. Further, the cellular walls of the central chamber of the isthmus (the vestibule) have a more finely granular structure than the hypoderm covering the ventral surface, and the dorsal border is soon modified, by a median furrow, into two thick ridges—about the level of the origin of the stalk of the operculum. The dorsal wall of the vestibule or mouth increases in thickness, and the opercular stalk sends out a process which fuses with the opposite side, so that two apertures now exist, viz., the mouth and that dorsad of the groove and ridges and formed by the external pit. Processes fuse with the point of junction, and others from the dorsal region of the now irregularly quadrangular part soon fill up the extended area (Pl. IV. fig. 21), leaving a small space dorsad of the mouth with its ventral edge marked by the groove before-mentioned, and showing a slight differentiation of its hypodermic wall. The vestibule, on the other hand, has glandular walls which stain deeply

l round. This dorsal pit, still retaining the dorsal groove th modified cells on each side, then disappears, but it comes ar the central nervous system, and perhaps performs a nsory function. Immediately thereafter the central rvous system occupies the region above the gullet—sepa- ted therefrom by strands of connective tissue with several ertures. The gullet has an internal lining of columnar icleated cells which stain deeply, surrounded by a circular uscular coat and an external investment of reticulated sue and nucleated cells. It is slung by several bands to e cœlomic wall around it, and instead of its cavity, now minished, having its long axis transversely placed, it is rtical. Below it is the commissure between the œsopha- al ganglia, above it is a large transverse space in which e dorsal vessel by-and-by appears, and the common duct of e thoracic glands occurs below the hypoderm above it, and ood-vessels lie internally. The investing cells and tissue crease in bulk, and the cut ends of numerous vessels are termingled, whilst median furrows give a cruciform aspect the central cavity in section, and longitudinal muscular res are more distinct within the circular coat. Below it the ventral blood-vessel in the median line. The nuclei the cœlomic cells are distinct and correspond with those vesting the alimentary canal. In this region (thoracic) e dorsal and ventral blood-vessels are of large size, and the te around the alimentary canal well developed as a ring of ngitudinal vessels in section (Pl. VI. fig. 35). The alimen- y canal now increases in size, and, in the preparations, ows a tendency to split into layers, the entire lumen being ed up by the various coats. Instead of the firm circular at with a few longitudinal fibres between it and the lumnar epithelial layer characteristic of the smaller ophagus, the area in section enlarges, the circular coat be- mes thinner, the longitudinal investment within it thickens, also does the cellular mucous layer, and there is a ten- ncy to separation of these coats in the sections—indeed, is clear that a change is taking place in the structure of e walls of the gut, probably representing a differentiated mach, the central part in the sections representing the aginated gullet and the larger separated external region e stomachal wall. The latter consists internally of a sely arranged, almost fibroid, cylindrical epithelium of iform thickness, then of the longitudinal fibres, followed the thin circular coat. The foregoing coats are invested the cellular and a vascular coat, which presents two riations, for the smaller region in front shows the cut ends

of numerous longitudinal blood-vessels and a large dorsal vessel, whereas the larger stomachal area, with its firm and thick walls and its central vertical slit, has externally a blood-sinus all round, and no separate dorsal vessel is now apparent. The narrower anterior region, therefore, with its numerous longitudinal vessels, may differ in function from the wider posterior region surrounded by a blood-sinus.

The enlarged region, with its thick walls, continues beyond the posterior termination of the thoracic glands—that is, after the formation of the ventral longitudinal muscles—and behind this where the body-wall is wider and more flattened. Food is more frequently present in the anterior part than in the wider posterior region. In the narrower part of the body, behind the foregoing, where the muscles become proportionally massive, the walls of the intestine are much folded and the area is large, but the structure of the wall is the same, though little cellular tissue surrounds the vascular sinus externally. Still further back the gut dilates into a wide chamber without folds and having the vascular sinus externally. Then it thickens laterally, apparently from a septum-like fold with a vertical **V**-shaped slit in the centre, the upper and lower arches being thin. Thereafter the firm and rather thick-walled canal shows a median pair of plates in section, as if from a fold or valve (Pl. V. fig. 31), and then, proceeding backward, enlarges so as to form the two halves of a pear which fill up the entire central area, a slit soon appearing in the middle of each half, and finally broadening out into a **T**-shaped fold, which runs from the transverse dorsal folds by a long median one to the ventral wall (Pl. V. fig. 27, *d.*). Such appears to be a valvular structure, and it is interesting that the lateral walls are thin, the ventral arch thick, and the dorsal somewhat thin in the median line, whilst the double stalk of the **T** is thick. The double stalk of the **T**, indeed, widens, has the structure of the gut, even to the vessels, on its walls, and gradually takes the place of the wall in front, for it is apparently a valvular invagination. If the serial sections can be relied on, it would seem that in this region the sinus breaks up into longitudinal vessels, the ventral remaining as before. The gut is of various shades of brown or reddish brown, the glands of its walls usually being brown by transmitted light.

Toward the tail (Pl. VI. fig. 34) the chief feature is the diminution of the canal and the larger size of the cells of the cylindrical epithelium, which is richly ciliated, lining it. The wall of the gut is sometimes folded, but no distinct

evidence of a typhlosole in this region occurs. Moreover, whilst the ventral vessel remains in position, the vascular branches on the walls are inconspicuous, though they seem to form a reticulate series. This part of the gut is often loaded with sandy débris, surrounded by the dilated but tough investment of the gut-wall, which appears to contain inner longitudinal and circular muscular fibres, though these are only visible in some sections, the tough investment in dilatation being apparently homogeneous, as observed in cases where the cylindrical epithelium has disappeared by maceration.

Nervous System.—The cephalic ganglia occur behind the bases of the branchiæ, their anterior border appearing about the level of the base of the opercular stalk as it begins to project from the somewhat quadrangular outline of the body in section. They form a fused mass above the œsophagus, supported in front by a dense group of nucleated cells with slight differentiations at each side, probably indicating the issue of nerves. Then a somewhat narrow band appears, chiefly of transverse fibres with two large nerves passing off at each end, one entering the base of the operculum on the left and the other entering the lateral tissues, whilst those on the right go to corresponding parts. The central part of the ganglia behind increases in bulk, the organ forming a broad band with an enlargement at each end, the whole surrounded by a coating of the nucleated cells, and many transverse commissural nerve-fibres appearing in the centre. The outer enlargement then bends downward and elongates ventrally, the transverse commissural fibres still persisting between the sides, but finally these are gradually replaced by the nucleated cells, and the great nerve-cords, widely separated, lie on each side of the œsophagus. Before this occurs, however, long commissural fibres pass between the trunks over the œsophagus. There is thus a variation from the ordinary arrangement in typical forms, in which these cords slant below the œsophagus and meet more or less closely in the first ganglion of the chain. The nerve-cords are wide apart in the region of the muciparous glands, and it is just after these have been passed in the backward progress that a small neural canal is observed at the inner end of each trunk—still at a considerable distance from its fellow, and with the fibres of the special interneural bands of longitudinal muscular fibres still present. The nerve-trunks lie at the inner edge of each ventral longitudinal muscle, which forms a comparatively thin plate on

each side. In the middle of the body the nerve-cords are still separated by a considerable interval, the median mesentery with the ventral vessel being attached to the basement-tissue between them, and each has a large neural canal filled with coagulable substance superiorly—occupying fully half the area. Instead of the more or less complete fusion of the ganglia at intervals, all that occurs in this type is a slight increase of the nerve-cells in the separate trunks and the passage of commissural fibres between them, with an increase of the neuroglia and its nuclei, the large neural canals undergoing no change. The interganglionic regions are recognized by the absence of the transverse or commissural fibres and of the increased neuroglia, and by the conspicuous condition of the median ventral mesentery with its blood-vessel, the strands of the mesentery passing directly to the basement-tissue.

Posteriorly the great nerve-cords are nearer each other, yet separated by a considerable interval. In section they have the same granular and streaked appearance, with a small neural canal at the upper and outer border, which lies against the inner margin of the ventral muscle. Numerous neuroglial nuclei occur at the commissural regions, which occur as in front. In longitudinal sections of the tail the nerve-cords follow every fold of the body-wall, dipping with a sharp angle into each pit, so that the neural canals have no noteworthy influence in this connection. The main direction of the nerve-fibres is longitudinal, and lateral branches leave at each dissepiment even to the tip of the tail.

Various authors have dealt with the general topography of the nervous system of the Serpulids: the earlier, such as De Quatrefages, described a smaller and a larger pair of cephalic ganglia which lie over the œsophagus, with the various nerves which proceed from them. Pruvot also held that there were two pairs of ganglia. E. Meyer, again, found that in *Psygmobranchus protensus* and *Eupomatus lunuliferus*, Clap., there were, in addition to the smaller central and the larger lateral lobes from which the great trunks to the branchial system arise, two accessory lobes to the latter; and his minute account of the branches from the cephalic ganglia and of those from the great nerve-cords (termed by him "spinal nerves") is excellent and his figures carefully drawn.

Reproduction.—In the ripe female, longitudinal sections of the tip of the tail show that the larger ova in the cœlomic spaces do not, as a rule, extend quite to the tip, about eight

segments presenting only small ova. As the sections pass downward from the dorsum toward the ventral aspect a process appears at the posterior edge of the rounded projection formed by each segment. This is the first indication of the segmental organ, and, in accordance with the structure of the parts, it appears earliest in the terminal segments, the process surrounding the cavity of the segmental organ. These processes, as well as the hypoderm of the segment, are outside the basement-membrane, which, with the circular fibres, separates them from the longitudinal muscles in the preparations. In transverse sections of the caudal region it is seen that these segmental cavities pass inward and downward, to open by a wide aperture on the ventral surface (Pl. VI. fig. 34, *ao.*) on each side of the ventral groove, and the ripe ova can be followed from their inner (cœlomic) aperture to the wide external one. These wide tubes might aptly be called, after Dr. Goodrich, cœlomoducts, since they transmit only the reproductive elements, which enter at the space above and to the exterior of the outer ends of the ventral longitudinal muscles. Besides the conspicuous larger ripe ova, smaller ova occasionally occurred in the canal. These segmental organs seem to be simple wide passages for transmitting the ova to the exterior without the complexity of structure observed in other forms. The inner opening is above and to the outside of the ventral longitudinal muscles, the canal curving round the latter to open on the ventral surface below it. The ovaries are situated over the ventral longitudinal muscles, the products being shed into the cœlom, in which further growth takes place. The females, from November onward for some months, have a bright pinkish coloration posteriorly, so that the breeding-season is prolonged.

In passing from behind forward the size of the body-wall and its muscles increases, but the general arrangement of the segmental organs and of the ovarian tufts is the same, the external apertures being outside the shallow ventral groove of the region and of the nerve-cord on each side.

So far as could be observed, no atrophy in the wall of the alimentary canal takes place in the ripe forms, and the muscles of the body-wall likewise are normal.

The Serpulids proper, in the separation of the sexes, are in contrast with such as *Spirorbis* and *Amphicora* (a Sabellid), in which Meyer observes that the anterior abdominal segments are female, the posterior male; whereas in *Salmacina* Giard held that this condition is reversed.

EXPLANATION OF THE PLATES *.

Plate I.

Fig. 1. Transverse section through the region of the cephalic ganglia, *cg.*, of a large *Bispira volutacornis*, Montagu. The chordoid skeleton, *ch.*, is at this level divided into lateral halves, whereas a little in front it forms a continuous arch from side to side. *cm.*, ganglionic commissure; *d.*, œsophagus; *cd.*, dorsal processes; *ct.*, thoracic collar or jacket; *m.*, anterior single mass of longitudinal muscles; *tgo.*, median or common duct of thoracic glands. Enlarged.

Fig. 2. Similar section anterior to the former, the chordoid arch being now complete. *bv.*, branchial blood-vessel, which is dividing into branches; *ch.*, chordoid skeleton; *vc.*, ventral region of the collar; *n.*, nerve. Enlarged.

Fig. 3. Transverse section of the cephalic region of a young example (partly macerated) at the origin of the branchial filaments indicating the tentacles, *t.* From its macerated condition the margins and posterior region are only diagrammatic. Slightly reduced from Zeiss oc. 4, obj. A.

Fig. 4. Transverse section of the distal region of a macerated branchial filament. × oc. 4, obj. A.

Fig. 5. Longitudinal section of a branchial filament in a similar condition, to show the arrangement of the chordoid skeleton. × oc. 2, obj. D.

Fig. 6. Longitudinal section of another filament, indicating the appearance of the cellular hypoderm covering the chordoid skeleton. Young example. × oc. 4, obj. D, with 2 inches of draw-tube.

Fig. 7. Transverse section of a tentacle, with its peculiarly curved lamellæ and its central skeleton and vessel.

Plate II.

Fig. 8. Transverse section of the anterior region of *Bispira volutacornis*, Mont. The dorsal muscles are proportionally small and somewhat rounded, the bristles are still at the dorsal edge, and the ventral longitudinal muscles are somewhat pointed externally, though little weight is to be placed on this feature. A complex series of muscular fibres passes from the dorsal longitudinal muscles downward to the inner border of the nerve-area, and above the point of meeting is the ventral blood-vessel, *vv. s.*, blood-sinus around the œsophagus. Enlarged.

Fig. 9. Transverse section a little behind the former. The dorsal and ventral longitudinal muscles are larger, whilst the absence of the sheets of muscle passing from the dorsal to the ventral aspect permits the oblique muscles, *om.*, to be seen passing to the edge of the nerve-cords. The commissure between the ganglia is marked, the ventral vessel being above it. The hypoderm in the mid-ventral line remains massive. Enlarged.

Fig. 10. Portion of the chordoid skeleton. The passage of processes

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* I am indebted to the Carnegie Trust for the artists' aid with these Plates.

from the external mass, *pr.*, throughout the reticulated central region and their fusion with the inner edge are indicated. *m.*, muscle. × 650 diam.

Fig. 11. Transverse section of the anterior region of *Bispira*. *d.*, œsophagus surrounded by firm muscular bands; *tg.*, thoracic glands with pale membranous tubes of chloragogenous tissue, *chl.*, attached; *nc.*, great nerve-cords. × oc. 4, obj. A.

Fig. 12. Transverse section of two branchial filaments with their chordoid axes before separation. × oc. 4, obj. D.

Fig. 13. Transverse section of a ventral longitudinal muscle in the posterior region of the annelid, with portions of a segmental organ, *so.* × oc. 4, obj. A.

Plate III.

Fig. 14. Transverse section of the ganglionic region of *Bispira volutacornis*, showing the eyes, *oc.* *cp.*, last trace of the external cephalic pit; *vf.*, ventral fimbriæ. × oc. 4, obj. A.

Fig. 15. Transverse section of the ganglionic region with the great nerve-cords, *nc.*, at the sides of the œsophagus and about the level of the chordoid skeleton; *ch.*, the external margin of which is not smooth, but has processes. Cells and fibres intervene between the dorsal muscles, *dm.*, and strong transverse fibres below them, whilst under these are vertical fibres, more or less mesenterial, in which the common duct of the thoracic glands, *tgo.*, lie. The massive ventral hypoderm, *hp.*, occurs inferiorly. The dorsal region is only partially represented, and the lower division of the great muscular mass is only indicated at *m.* The preparation is somewhat stretched inferiorly. Enlarged.

Fig. 16. Transverse section toward the termination of the thoracic glands, *tg.*, which are represented by two tubes. *cm.*, connective tissue with nuclei and muscular fibres, probably part of the oblique muscle of the side. × oc. 4, obj. A.

Fig. 17. Transverse section of the region of the nerve-cords in the middle of the body. *hp.*, hypoderm; *nc.*, nerve-cords; *vv.*, ventral blood-vessel with a coating of chloragogenous cells, *chl.* × oc. 4, obj. A.

Fig. 18. Slightly oblique section of a branchial filament of *Pomatocerus triqueter*. *bv.*, blood-vessel; *cœ.*, cœlomic space; *n.*, nerve. × oc. 2, obj. D.

Fig. 19. Transverse section of a branchial filament toward the base and where its inner edge is produced into a groove with ciliated sides. × oc. 2, obj. D.

Plate IV.

Fig. 20. Transverse section of the anterior region of *Pomatocerus triqueter*, L., near the origin of the opercular stalk (*op.*). *d.*, the vestibule; *ds.*, dorsal pit; *hpi.*, modified hypoderm covering the inner surface of the thoracic collar or jacket and the outer side of the body-wall. The dorsal surface is to the right. × about 35 diam.

Fig. 21. Transverse section of the body-wall in front of the foregoing. The opercular stalk (*op.*) projects much further, the dorsal pit (*ds.*) is larger, and the slits (*bf.*) indicating the spaces between the branchial filaments are present. Spaces (*cœ.*), apparently cœlomic, occur on each side. × about 35 diam.

Fig. 22. Transverse section of the region in front of fig. 21, in which the opercular stalk is separating and the slits (*bf.*) for the formation of the branchial filaments making rapid progress on the other side. On the ventral surface (left in the figure) the thoracic collar is free. Similarly magnified.

Fig. 23. Transverse section after the separation of the opercular stalk and when slits are appearing on the left or opercular side (upper in the figure). The great expanse of the vestibule, *d.*, is noteworthy; *n.*, branchial nerve, the others lie toward the inner ends of the slits. Only the inner branchial nerve, *n.*, is indicated in this figure.

Fig. 24. Transverse section of the tip of a branchial filament of the foregoing. The blood-vessel occupies the centre. It is richly ciliated in life. × oc. 2, obj. D.

Fig. 25. Longitudinal section of a filament of *Pomatocerus triqueter*, L., with portions of pinnules. × oc. 2, obj. D.

Plate V.

Fig. 26. Transverse section of the anterior region of *Pomatocerus triqueter*, L., with the thoracic glands, *tg.*, in full development, that on the left showing the origin of the duct which joins that of the opposite side at the median outlet (*tgo.* in Pl. III. fig. 15 for *Bispira*). *cm.*, cellular appendix of the thoracic gland; *d.*, œsophagus with its chloragogenous coat; *dm.*, dorsal longitudinal muscles; *hyp.*, modified hypoderm; $m.^1$, special anterior median muscular layer on the dorsum; $m.^2$, special ventral layer of muscle; *nc.*, nerve-cords. Above the gullet is the dorsal blood-vessel in the median mesentery, and a space occurs above it between folds of mesentery, but soon disappears. × about 35 diam.

Fig. 27. Transverse section of the body-wall toward the posterior region. The dorsal muscles, *dm.*, are of great size, with scarcely a trace of separation in the mid-dorsal line; *vm.*, ventral muscles; *ve.*, ventral vessel with chloragogenous cells externally. The outline of the gut is T-shaped. × about 35 diam.

Fig. 28. Transverse section of an anterior foot with the hook-pad about the level of the diminishing thoracic gland, *tg.*; *ab.*, incipient muscular fibres of the process opposite the external papilla, *p.* In this section none of the peculiar clavate nucleated cells are visible. × oc. 2, obj. A.

Fig. 29. Section behind the foregoing cutting the superficial part of the hook-pad, and showing the greatly developed hypodermic cells with the nuclei situated externally, and forming an elastic cushion in connection with the dense row of minute hooks. *tg.*, thoracic gland. × oc. 2, obj. A.

Fig. 30. Transverse section of the opercular stalk in another example, in which the central area is chordoid or areolar in aspect. The nerves are not entered. × oc. 4, obj. A.

Fig. 31. Transverse section of the alimentary canal, showing lateral folds of the mucous membrane, almost valvular in appearance. × 350 diam.

PLATE VI.

Fig. 32. Transverse section of the opercular stalk (now shaped like a cocked hat) after the lateral ridges have appeared. The great development of the modified hypoderm (*hpl.*) is conspicuous. *n.*, nerves; *bt.*, basement-tissue, which is highly developed. × oc. 4, obj. A.

Fig. 33. Oblique section of the distal end of the operculum, showing on the right the presence of the ridge and on the left a reticulated aspect of the region beyond after decalcification. × oc. 2, obj. A.

Fig. 34. Oblique section of the tip of the tail of a mature female specimen. *ov.*, ova; *vm.*, ventral longitudinal muscles; *ao.*, external aperture of the modified segmental organ; *d.*, anus. The canal is richly ciliated in this region. × oc. 2, obj. A.

Fig. 35. Transverse section of the œsophageal region, with its thick mucous lining internally, its chloragogenous coat (*chl.*) externally, with its plexus of blood-vessels (*bv.*). *dv.*, dorsal blood-vessel. × 280 diam.

II.—*New Forms of* Dendromus, Dipodillus, *and* Gerbillus.

By OLDFIELD THOMAS.

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Dendromus (*Poemys*) *exoneratus*, sp. n.

Closely allied to *D. nigrifrons* of East Africa and Uganda, but larger and with whitish ear-patches.

General colour as in *nigrifrons*, but the blackish frontal patch and the dorsal line less developed. At the anterior base of the ears, just in front of the base of the proectote, there is a pair of whitish patches, each about 3 mm. in diameter, which throw up by contrast the blackish frontal patch. These whitish patches are found in all the six specimens from Nigeria available, and in none of those from Uganda and British East Africa.

Skull decidedly larger than that of *nigrifrons*.

Dimensions of the type (measured in flesh by collector):—

Head and body 61 mm.; tail 71; hind foot 18; ear 13.

Skull: greatest length 21·3; condylo-incisive length 19; zygomatic breadth 10·5; interorbital breadth 3; breadth of brain-case 9·7; palatal length 8·7; upper molar series 3·2.

Hab. Panyam, Bauchi Province, Northern Nigeria. Alt. 4000′.

Type. Adult female. B.M. no. 12. 1. 16. 19. Original number 83. Collected 16th September, 1911, and presented by the Rev. G. T. Fox. Six specimens.

Distinguished from its ally *D. nigrifrons*—near zoologically, but very distant geographically—by its longer skull, the whitish pre-aural patches, and the reduced black markings.

Dipodillus jordani, sp. n.

A very small gerbil, apparently representing in Algeria the little *D. mariæ* and *D. henleyi* of Lower Egypt.

Size less than in *D. simoni*, greater than in *mariæ* and *henleyi*. General colour dull sandy, very much as in the first-named, the dorsal hairs prominently tipped with dark brown, so that the general tone is much darker and duller than the bright clear buffy of *D. henleyi*. Supraorbital light patches not very white, but extended backwards nearly to the ear, where they almost join the snowy white post-auricular patches. Ears small, their edges brownish. Soles naked, with the usual six pads. Tail longer than the head and body, greyish white below, pale brownish above and at the end, which is inconspicuously pencilled, its hairs about 5 mm. in length.

Skull with the broad brain-case and small muzzle characteristic of *simoni*, *henleyi*, and other allied species. In size it is markedly less than in *simoni*, larger than in *mariæ* and *henleyi*. Supraorbital edges with fine sharp and slightly overhanging ledges, about as in *D. henleyi*. Bullæ large, exceeding those of the larger *D. simoni*, about equalling those of *D. henleyi*. Molars small.

Dimensions of the type (measured in the flesh):—

Head and body 67 mm.; tail 80; hind foot 19·5; ear 9.

Skull: greatest length 22·4; greatest diagonal length to back of bullæ 22·3; condylo-incisive length 20·2; nasals 7·7; breadth of brain-case 11·6; palatal foramina 3·8; diagonal horizontal diameter of bulla 8·5; upper molar series 3·0.

Hab. (of type). Guelt-es-Stel, Central Plateau of Algeria. Alt. 900 m.

Type. Old male. B.M. no. 12. 6. 12. 100. Original number 111. Collected 22nd April, 1912, by Dr. K. Jordan. Presented by Lord Rothschild.

I have hitherto hesitated to describe this little gerbil on

account of its general resemblance to *D. simoni*, Lataste, from near the same region. But I now see that its longer tail, smaller skull, smaller teeth, and proportionally larger bullæ indicate that it is not really related to that animal, but is an Algerian ally of the Lower Egyptian *D. mariæ*, Bonh., and *D. henleyi*, de Wint., from both of which it differs by its larger size. I have named it in honour of its captor, Dr. Jordan, of Tring, to whose efforts in collecting Algerian small mammals the National Museum is so largely indebted.

Dipodillus arabium, sp. n.

Allied to *D. famulus*, but with less heavily tufted tail and even larger bullæ. Sides not completely naked.

Size rather smaller than in *famulus*. General colour of the same soft drabby fawn, darker on the back, paler and clearer on the sides. Top of nose with scarcely a trace of a dark nose-patch. White patches over eyes and behind ears well marked. Ears rather short, their proectotc coloured like the head, not darkened. Hands and feet white as usual. Soles essentially naked, but there are a number (twenty to thirty) of small hairs on the terminal third, upon and between the pads, thus showing an approximation to the condition in *Gerbillus*; pads six in number, the proximal ones small. Tail rather shorter than in *famulus*, well-haired and tufted as compared with most members of the group, but with nothing like the remarkable tuft found in *famulus*; whitish below and on the sides, its upper surface mixed brown and fawn, the terminal tuft brown, but perhaps like that of *famulus* black when unbleached.

Skull with narrow interorbital region, low and broad brain-case, and bullæ even larger, though very slightly so, than in *D. famulus*.

Dimensions of type (measured in flesh) :—

Head and body 86 mm.; tail 140; hind foot 24; ear 13·5.

Skull: greatest median length 28·7; greatest diagonal length 29·5; condylo-incisive length 25·6; zygomatic breadth 15; nasals 10·8; interorbital breadth 5·2; breadth on lip of meatus 15·8; palatal foramina 4·6; greatest diagonal horizontal diameter of bullæ 11·2; upper molar series 3·7.

Hab. Tebuk, on the Hedjaz Railway, Arabia. Alt. 2000′.

Type. Adult male. B.M. no. 10. 3. 12. 1. Original number 7. Collected 3rd January, 1909, by Douglas Carruthers. Two specimens.

This pretty species seems only nearly related to the *D. famulus* of Aden, the other species of this region all having comparatively small bullæ. Its partially hairy soles seem peculiar to itself and to the species next described.

On the same expedition Mr. Carruthers also collected, at a place about 200 miles east of the Dead Sea, an example almost topotypical of, and certainly referable to, *D. dasyuroides*, Nehring *. But I fail to see any reason for its distinction from *D. dasyurus*, Wagn., from the neighbouring coast of the Red Sea, of which we have two examples from Sinai, presented by the Giza Zoological Gardens. Nehring himself gives no valid reasons for the distinction, merely saying that the species "appears to be new, although allied to *D. dasyurus*, which is so insufficiently described that nothing can be done without examination of the type." Both *dasyurus* and *dasyuroides* have bullæ of the comparatively small size usual in the genus.

Dipodillus hilda, sp. n.

A Moroccan species with partially hairy soles.

Size and general appearance very much as in the browner forms of *D. campestris*, to which the type has been hitherto referred. General colour above russet- or cinnamon-brown, not unlike the deepest and richest specimens of *Apodemus sylvaticus*. Sides clearer and lighter, approaching "sayal-brown." Under surface, as usual, pure white. Face with scarcely perceptible supraorbital light patches; post-auricular white patches present. Ears with their proectote prominently blackish, contrasting markedly with the general colour of the head; hairs on metentote white. Hands and feet white. Soles with six pads, the region between the second and posterior pairs thinly clothed with fine hairs, very much as in *D. arabium*. Tail buffy brown above, darkening terminally, whitish below; the tip probably not heavily tufted, but this part is imperfect in the type.

Skull considerably smaller and narrower than that of *D. campestris*, apparently like that of *D. arabium*, but the bullæ have been lost in the type.

Measurements of the type:—

Tail (imperfect) more than 100 mm.; hind foot (wet) 22·5; ear 15.

Skull: greatest length 28; zygomatic breadth 15; nasals

* SB. Ges. Nat. Berl. 1901, p. 173.

11·2; interorbital breadth 5·2; breadth of brain-case 13·5; palatilar length 12·5; palatal foramina 5·1; upper molar series 3·5.

Hab. Northern Morocco. Type from the sea-coast 70 miles (122 kilometres) south-west of Tangiers.

Type. Old female. B.M. no. 86. 9. 10. 1. Collected and presented by Capt. Savile Reid.

The specimen on which this species is founded has lain for 30 years among the series of *D. campestris*, to which it has a strong superficial resemblance. But examination of its feet and skull shows that it has really nothing to do with that animal, but represents in Morocco the same type of gerbil as that just described as *D. arabium*; it is therefore a form entirely new to the fauna of Barbary.

Dr. Cabrera has noted that there is a gap in the distribution of *D. campestris* just in the region where Capt. Savile Reid captured this gerbil.

Gerbillus calidus, sp. n.

A pale desert-coloured species allied to *G. paeba*.

Size about as in *paeba*. General colour above pale sandy fawn, not or scarcely darkened on the back. Under surface wholly snowy white, the white rather high up on the sides, and wholly enclosing the fore limbs, on to which the darker body-colour does not encroach. Area round eyes whitish, not sharply defined; a small white patch behind ears. Ears pale fawn, like the head, their edges not darkened. Feet wholly white; soles hairy throughout except for a round patch on the heels, and at the bases of the digits just distal to the large compound sole-pad. Tail whitish, the upper surface a little darker; the slight terminal crest browner.

Skull more slender than that of *G. paeba*, the bullæ smaller.

Dimensions of the type (measured in flesh):—

Head and body 85 mm.; tail 99; hind foot 24; ear 17.

Skull: greatest length 28·3; condylo-incisive length 24·8; zygomatic breadth 14; nasals 11·2; interorbital breadth 5; breadth of brain-case 13·3; palatal foramina 5·3; diagonal horizontal diameter of bulla 8·2; upper molar series 4·0.

An older specimen has a tail 115 mm.; hind foot 25·5; greatest length of skull 30; bulla 8·8.

Hab. (of type). Molopo, W. of Morokwen, Bechuana-land. Other examples from Otjimbingue, Damara-land (*Andersson*).

Type. Young adult male. B.M. no. 4. 10. 1. 72. Original

number 76. Collected 11th July, 1904, by R. B. Woosnam. Five specimens examined.

This is the species quoted as *Gerbillus paeba schinzi*, Noack, by Schwann *, who rightly identified it with Andersson's Damara specimens so named by me some years before. But in making that earlier determination I was clearly in error, as Noack's animal was much larger, had naked metatarsals, and was probably some form of *Taterona*.

From *G. paeba* this gerbil is readily distinguishable by its much paler colour, the complete inclusion of the fore-limbs in the white body area, and its smaller bullæ.

Gerbillus paeba broomi, subsp. n.

Paler than true *paeba*, the foot longer.

Colour dark sandy fawn, intermediate between that of *G. calidus* and of true *paeba*; the hairs of the back pinkish buff, heavily darkened by their brown or blackish tips; the sides clearer pinkish buff. Under surface as usual white, but this does not pass across the fore limbs, as on the front of these the body-colour runs down to the wrists. Face rather greyer than body. Postorbital and postauricular light patches present, but inconspicuous. Ears greyish with a narrow brown edging. Hands and feet white; soles hairy to the same extent as described above in *calidus*.

Dimensions of the type (measured in the skin) :—

Head and body 100 mm.; tail 109; hind foot (wet) 28·5.

Hab. Port Nolloth, Namaqualand.

Type. B.M. no. 98.9.3.2. Collected September 1897 and presented to the National Museum by Dr. R. Broom.

A paler form of Smith's *G. paeba*. There is in the Museum collection an example of this group from Deelfontein, Central Cape Colony, so closely matching Smith's type (which was said to come from north of Latakoo) that I am disposed to think some mistake was made by Smith as to the region where his type was got. For north of Latakoo would have been in the desert area, where the desert form *G. calidus* occurs, while the type of *paeba* (which is also that of *tenuis*) is of strong non-desert cinnamon-colour, very like the Deelfontein specimen. Possibly it was obtained on the way out or home, as Smith passed, and that then it was wrongly supposed to have been got at his farthest north.

* P.Z.S. 1906, i. p. 106.

[II.—*New Species of Indo-Malayan Heterocera, and Descriptions of Genitalia, with reference to the Geographical Distribution of Species resembling each other.* By Colonel C. SWINHOE, M.A., F.L.S., &c.

[Plates VII.–XI.]

THE geological distribution of species has always been the weak point of all lepidopterists; the superficial resemblance of specimens from widely different parts of the globe has sufficed to declare them as of identically the same species. I have endeavoured in this paper to show that this is easily disproved by the examination of the genitalia. When the genitalia are so different as to make it impossible for breeding with each other, it is positive proof of the difference of species. Classification based upon eye-judgment alone is bound to be faulty. There are, of course, many problems before us still: species which appear to the eye abundantly distinct have a habit of presenting similar genitalia; on the other hand, species which to the eye appear to be identical possess genitalia which are very distinct from each other.

I am much indebted to the Rev. C. R. N. Burrows for the great pains he has taken in dissecting the moths I have sent him, and to Mr. F. N. Pierce of Liverpool, to whom all Mr. Burrows's drawings were submitted by him, and to them both for their joint report. All the Plates were drawn by Mr. Burrows and the text-figures by Mr. Pierce, and the remarks on the genitalia of the different species are extracts from their joint reports.

Family **Agrotidæ**.

Chloridea marmada, nov.

♂. Palpi, head, thorax, and fore wing whitish flesh-colour, nearly white, without any markings whatever except black dots on the vein and on the outer margin of the wing; hind wing pure white, with a black outer marginal band, cilia white. Underside: both wings white, fore wing with a discoidal black spot and a short medial subterminal black band, hind wing with a similar black band; abdomen with the basal segments white above, the two middle segments red-brown, the anal segments shading paler; anal tuft with pale

red-brown hairs. On the underside the body and legs are white.

Expanse of wings, ♂, $1\frac{2}{10}$ inch.

Hab. Roebourne, Australia.

The shape of the wings is similar to that of *C. obsoleta*, Fabr., but the fore wing is narrower.

Euxoa cabara, nov.

♀. Head, thorax, and fore wing ochreous brown: fore wing with the costa yellowish, with black and pale yellow spots; a black spot in the cell and another at the end; subbasal, antemedial, medial, and postmedial outwardly curved transverse lines of black dots, the first two more or less obsolete hindwards, the last outwardly edged by a pale yellowish line; between this and the margin there is a pale brown band composed of a double line of spots, the margin with black lunules; cilia brownish yellow, with basal black minute lunules, a yellowish line between the two rows of lunules: abdomen and hind wing pale brown, the cilia yellow, with minute black lunules. Underside: fore wing with black and yellow dots on the costa towards the apex; a double discal row of brown spots, the outer row with a black spot on the costa; the whole inner surface of the wing from these rows to the base of the wing is brown, the outer portion whitish grey: hind wing whitish grey, irrorated with brown atoms; a black discoidal spot, an outwardly curved brown macular band in continuation of the inner macular row of the fore wing; cilia of both wings whitish grey, with black basal points.

Expanse of wings, ♀, $1\frac{3}{10}$ inch.

Hab. Padang, W. Sumatra; three specimens.

Family **Acronyctidæ**.

Genus AMPHIPYRA, Ochs.

I have long been in doubt that *A. sarnia*, Felder, from Japan, was the same as *A. pyramidea*, Linn., from Europe; and, moreover, I have always been of opinion that there were two species in Japan, and therefore sent examples of both to Mr. Burrows, and also an example of *A. magna*, Walker, from the Punjab, and his and Mr. Pierce's joint report, com-

paring their genitalia with that of the European species *A. pyramidea* from Mucking in Essex, is as follows:—

"These mounts show four distinct species closely allied.

"Plate no. IX. fig. 12. *surnia* (Yokohama, Japan) (mounted dorsal uppermost). Valve squared, uncus large, cornuti long and fine, no pips on 'vessica.'

" " 13 *a*. *pyramidea* (England). Valve pointed upwards, many hairy cornuti, many pips.

" " 14. *magna* (Punjab). Valve pointed but not upturned, enormous cornuti, pips large and few.

" " 13. *yama* (Asama Yama, Japan). Valve square, the uncus agrees with the other forms but much smaller, there are a large number of cornuti."

Amphipyra yama, nov.

♂ ♀. Palpi, head, and body ochreous brown; collar and thorax pricked with grey and white: fore wing with a short longitudinal black streak inside the end of the cell; subbasal line indicated by a black mark on the costa; antemedial line consisting of obscure black lunules pricked with white; a postmedial sinuous line of black lunules outwardly edged with white; some black streaks on the veins between this and the outer margin, which contains black lunules at the vein-ends inwardly edged with white; cilia ochreous brown: hind wing pale dull red, without markings. Underside: both wings brownish grey; a pale, outwardly curved, brownish discal band, and on the hind wing a discoidal spot; face, pectus, thorax, and legs dark greyish brown; tarsi black.

Expanse of wings $2\frac{2}{10}$ inches.

Hab. Asama Yama, Japan.

Allied to *A. surnia*, Felder; fore wing narrower, and the apex subacute; genitalia different (Pl. IX. fig. 13).

Family **Erastriidæ**.

Lophoruza cretonia, nov.

♂ ♀. Head and body ochreous brown; wings dull ochreous, irrorated with brown, markings red-brown: fore wing with the costa brown, with some darker spots; faint transverse

somewhat sinuous lines, subbasal and antemedial, the outer third of the wing brown, paling towards the costa; a large yellowish-white patch near the hinder angle, consisting of three conjoined spots, decreasing in size from the hinder margin upwards, the patch with broad dark brown sides containing small pale dots on the margins: hind wing darker in colour, with a central yellowish space.

Expanse of wings 1 inch.

Hab. Coomoo, Sherlock River, Australia.

Cerynea sumatrana, nov.

♂. Head and body dark chocolate-brown; thorax with a yellow spot on each side; abdomen with yellow bands, most prominent on the first two segments: wings with the basal half ochreous, thickly irrorated with brown on the basal two-thirds, the outer portion of the ochreous space with the minute irrorations leaving an ochreous band across the middle of the wings, not reaching the costa on the fore wing, its outer edge outwardly angled above the middle and below the middle on the hind wing; the costal space and outer marginal space dark chocolate-brown; the outer margin of both wings with black spots; cilia dull ochreous, with brown spots and brown tips. Underside: fore wing blackish brown, an ochreous spot at the end of the cell, hinder margin with the basal half ochreous; hind wing blackish brown, an ochreous middle band and a black spot in the cell.

Expanse of wings $\frac{9}{10}$ inch.

Hab. Padang, W. Sumatra.

Family **Stictopteridæ**.

Stictoptera talagi, nom. nov.

Stictoptera tongluana, Swinhoe, Ann. & Mag. Nat. Hist. (8) xix. p. 338 (1917).

Hab. Talagi (*Everett*).

I made a mistake in reading the label on this species. Talagi is a small island off Isabel Island in the Solomon group; Tonglu is in Sikkim. It is therefore necessary to alter the name of the species.

Family **Sarrothripidæ**.

Characoma sumatrana, nov.

♂. Resembles *Characoma curiosa* *, Swinhoe, from Burma.

* Trans. Ent. Soc. 1890, p. 235.

Head, body, and fore wing grey, irrorated with minute chocolate-brown atoms; markings chocolate-brown; a band behind the head: fore wing with a duplex, outwardly and evenly curved band across the wing at the basal third (*curiosa* also has this band, but it is sharply angled inwards below its middle); some brown marks at the base, costa and hinder margin of the wing, a patch on the costa extending from near the band to near the apex; a fine medial, waved, transverse line, which does not reach the hinder margin; a small ringlet in the interno-median interspace beyond the middle, some spots in a row above it; a sinuous subterminal line; a double marginal line with its upper half filled in with brown; cilia grey, with some pale brown marks: hind wing white, with some slight grey suffusion on the outer margin.

Expanse of wings, ♂, $1\frac{8}{10}$ inch.

Hab. Padang, W. Sumatra.

Blenina alena, nov.

♂ ♀. Head, thorax, and fore wing uniform dark grey; a brown line behind the head and a brown line down each side of the thorax; abdomen pale grey: fore wing irrorated with minute brown atoms; subbasal line represented by a black spot on the costa and another below it; antemedial line very sinuous, commencing with a spot on the costa, then outwardly curved, bent inwards at the cell, then outwards into a long acute angle, and runs down to the hinder margin; postmedial line also very sinuous and more or less dentate in parts, outwardly highly curved, some marginal black points and pale grey cilia: hind wing greyish white, the costal and outer marginal spaces suffused with brownish grey, the veins dark grey on the outer half of the wing. Underside: fore wing blackish brown, a small space at the base and the hinder margin white: hind wing much as it is on the upperside.

Expanse of wings, ♂ ♀, $1\frac{3}{10}$ inch.

Hab. Mackay, Queensland.

Selepa oranga, nov.

♀. Palpi, head, body, and fore wing blackish brown; the ground-colour of the fore wing is really pale pinkish, but it is most thickly covered with blackish irrorations, leaving a pale streak below the costa and a broader pale streak from the costa near the apex to the middle of the hinder margin; reniform and orbicular represented by white dots, the latter

surrounded by blackish and again by pale pinkish; a duplex, oblique, and highly curved line, centred with white from the median vein near the base to the middle of the wing above the hinder margin; above this is a similar circular duplex line outside the space round the orbicular, these lines more or less indistinct; an obscure pale pinkish space on the hinder margin beyond the middle; marginal line black, inwardly edged with pale pinkish on both sides; cilia brown; hind wing dark grey, the outer margin brownish; outer marginal line black, somewhat sinuous, outwardly edged with a pale line; cilia brown.

Expanse of wings, ♀, 1 inch.

Hab. Sarawak, Borneo.

Gadirtha guineana, nov.

♂ ♀. Palpi greyish white, second joint black on the sides; head and thorax mixed grey and white; a black stripe behind the collar and one on each side of the thorax; abdomen dark grey, with darker segmental bands: fore wing with the ground-colour white, densely irrorated with pale chocolate-brown; costa with a large black antemedial patch and a smaller curved subapical patch, and two black spots between them; orbicular and reniform round black rings, pale inside and dull ochreous spot in their centres, the former small, the latter very large; black marks below the first patch, some black spots in an oblique row in the disc, black marginal lunules at the vein-ends, and a number of black spots close together on the outer half of the hinder margin, above which there is some whitish suffusion: hind wing pale grey, outer margin broadly blackish; cilia of both wings pinkish grey.

Expanse of wings, ♂ ♀, $2\frac{1}{10}$–$2\frac{2}{10}$ inches.

Hab. Dinawa, 4000′, Mt. Kebea, 6000′, New Guinea (*A. E. Pratt*).

Several examples. Some of the specimens have a dark central suffusion, somewhat resembling *G. impingens*, Walker; genitalia different (Pl. IX. figs. 10 & 11); note the difference in the valvule, costa, uncus, and the extraordinary development of the gnathos, which is new to us; the tegumen is also utterly different.

Family **Acontiidæ**.

Genus MAURILIA, Möschler.

M. iconica, Walker, is quite different from *M. cervina*,

Walker—two cornuti in the latter, three in the former, one short and two gementate, besides other differences shown in the figures. *M. undaira*, mihi, and *M. tunicata*, mihi, are also distinct species; besides the enlargement of the costa, the cornuti are absent, the rugose patch on the vesica is much more prominent, and there are many other features which the figures will show (note arm on costa and cornuti). I have *undaira* from New Guinea and *tunicata* from New York, N. Queensland, and had specimens from both localities examined (Pl. VII. figs. 1, 2, 3, 3 *a*, & 4).

Maurilia instabilis.

Anomis instabilis, Butler, Ill. Het. B.M. vii. p. 72, pl. cxxxi. fig. 3 (1889).
Maurilia iconica, Hampson (part.), Phal. ii. p. 373 (1912).

The prominent black discoidal lunule on the fore wing differentiates it from *iconica*; the genitalia is also somewhat different; note the thickening of patch on costa and the two cornuti instead of three.

In my collection from Kurseyong and the Khasia Hills.

Pl. VII. fig. 1 *instabilis*, fig. 2 *iconica*.

Maurilia tunicata, nov.

♂. Palpi brown, first joint white beneath; head, thorax, and fore wing of the type-specimen pale rufous tinged with ochreous; in the other examples the colour is darker, markings indistinct, but apparently similar to those of *M. undaira*; hind wing pale black, veins dark black; abdominal area somewhat paler. Underside blackish, the costa and hinder margin of the fore wing and the costa and abdominal margin of the hind wing whitish; pectus, body, and legs white, legs with brown stripes; tarsi black, with white rings.

Expanse of wings, ♂, $1\frac{3}{10}$ inch.

Hab. Cape York, N. Queensland, Australia; two examples.

Pl. VII. fig. 3. Note the difference of arm on costa and cornuti.

Maurilia undaira, nov.

♂. Palpi, head, body, and fore wing purplish brown; two antemedial lines, a large round whitish reniform, with a minute yellow centre ringed with brown, this large spot interrupting the medial line, all erect and sinuous, the subbasal line not distinguishable; two oblique, sinuous, post-

medial lines from the costa beyond the middle to the hinder margin near the angle; a submarginal sinuous series of black points, all these lines somewhat indistinct: hind wing blackish brown, becoming pale towards the abdominal margin; no markings; cilia of both wings concolorous with the wings. Underside rather pale purplish black: fore wing with centre suffused with black, the hinder marginal space whitish grey, and the costa grey: hind wing with some (but less) black suffusion in the middle; a discoidal black lunule; the abdominal marginal space pale: body and legs of the colour of the wings, legs with white stripes, tarsi with white rings.

♀. Paler, with a rufous tinge; markings similar.

Expanse of wings, ♂ $1\frac{3}{10}$, ♀ $1\frac{6}{10}$ inch.

Hab. Ekeikei, 1600', New Guinea.

Genitalia distinct, note arm on costa, no cornuti (Pl. VII. figs. 3 *a* & 4).

Maurilia fortis, nov.

♀. Palpi, head, thorax, and fore wing dark rufous, with a curved dark brown patch below the middle of the costa, containing a dull scarlet patch against the costa and a curved similarly coloured spot on its lower outward side; a white dot ringed with brown in its centre, two grey large spots or patches inside the outer part of the brown space, and a white dot; lines a little darker than the ground-colour; subbasal lines short; two oblique sinuous antemedial lines, two similar postmedial lines, a submarginal series of black dots; cilia brown, with white tips: hind wing pale brown, costal space grey, no markings; cilia ochreous, with white tips. Underside: body white; legs white, with a brown stripe on the upper side; tarsi dark brown, with white rings: wings grey, fore wing with some brownish suffusion in the cell region; cilia of both wings brown.

Expanse of wings, ♀, $1\frac{7}{10}$ inch.

Hab. Ekeikei, 1500', New Guinea.

Maurilia dalama, nov.

♀. Palpi pale red, the last joint brownish; thorax dark pinkish brown; collar and fore wing pinkish red; abdomen pinkish grey, with brown segmental lines: fore wing uniform pinkish red, lines slightly darker; indistinct subbasal line short, antemedial line slightly sinuous, erect; a faint lunular

discoidal mark, a short sinuous mark above it, another sinuous line inwardly below it; a postmedial highly curved and recurved line; a row of submarginal black dots; cilia concolorous with the wing: hind wing white, without markings. Underside: body, legs, and wings white, somewhat shining, without any markings.

Expanse of wings, ♀, $1\frac{2}{10}$ inch.

Hab. Queensland, Australia.

Carea intermedia, nov.

♂. Head and thorax dark flesh-pink; a dark line down each side; abdomen white, with some flesh-pink suffusion and segmental lines: fore wing clear, pale flesh-pink; a darker line from the costal third to a little beyond the middle of the hinder margin, nearly straight, slightly bent inwards below the costa; a dark inwardly and evenly curved line from the costa one-fourth from the apex to the hinder angle, some slight darker shading on the upper half; on the inner side of this line a faint line runs close to it; outer marginal line and cilia dark brown: hind wing pure white, without markings; cilia brown.

♀. More pink than the male; the fore wing is very uniform in shade of colour, with very faint traces of the transverse lines.

Expanse of wings, ♂ ♀, $1\frac{4}{10}$ inch.

Hab. Kandy, Ceylon, and Palni Hills, S. India.

The lines are disposed like those in *C. subtilis*, but it is altogether a different-looking insect. I have *subtilis* of both sexes from different parts of India and also from Ceylon.

Pl. VIII. fig. 6 *subtilis*, fig. 7 *intermedia*; the genitalia varies but little.

Carea innocens, nov.

♀. Palpi, head, thorax, and fore wing bright pinkish red; palpi white beneath, the colour of the wing very uniform and bright; the only lines at all distinguishable are two, and these are very indistinct—the first a slightly curved line a little darker than the ground-colour from the costa before the middle to the hinder margin near the angle, the other an erect whitish line from the costa one-fifth from the apex to the hinder angle; the cilia is brown, the outer margin of the wing angled as in *C. subtilis*: hind wing white, the outer margin narrowly suffused with pale pinkish red; cilia similarly coloured, with pale basal line: abdomen white, with

dorsal black dots. Underside: both wings pale pinkish red, hinder marginal space of fore wing glistening white, the base and abdominal half of hind wing whitish; body and legs white; upperside of legs pinkish red.

Expanse of wings, ♀, 1½ inch.

Hab. Palhi Hills, Bandora, near Bombay.

Acontia dohertyi, nov.

♀. Palpi yellow, its upperside dark brown; head, thorax, and fore wing bright clear yellow, very uniform in colour: fore wing with the markings dark chocolate-brown, costal line chocolate-brown, subbasal line hardly visible, antemedial line inwardly curved obliquely from the costa, one-third from the apex, then inwardly curved to the hinder margin one-third from the hinder angle, forming a very acute angle above its middle, its point continued to the outer margin below the apex; a curved line from the costa before the apex to the end of the other line below the apex; postmedial line similar in shape, its point with a line connecting it with the antemedial line at its middle; a spot at the upper end of the cell, a fine anteciliary line, and dark chocolate-brown cilia: hind wing yellowish white, without markings; cilia pale chocolate-brown. Underside: both wings yellowish white, without markings.

Expanse of wings $1\frac{4}{10}$ inch.

Hab. Sambawa Island, west of Java (*Doherty*).

Acontia talauta, nov.

♂. Palpi, head, thorax, and fore wing dark chrome-yellow: fore wing with the lines rufous, antemedial line very acutely outwardly angled to a point on the median vein, then inwardly oblique to the hinder margin at the basal third; postmedial line similarly shaped, commencing on the costa near the apex and ending on the hinder margin a little beyond the middle; a slightly curved short line from the costa one-fourth from the apex, almost parallel with the upper part of the postmedial line; a black dot close to the apex of the wing, the outer marginal space broadly suffused with dark red-brown, its inner side irregular and highly curved; much as in *A. transversa*, Guen.; outer margin of the wing with a line of yellow lunules, cilia dark brown: hind wing yellowish white, nearly white, no markings, marginal line yellow and sinuous, cilia brown. Underside pale yellowish grey, the hinder marginal space of the fore wing and inner portion of

the hind wing paler; pectus dark brown, body and legs greyish brown.

Expanse of wings, ♂, $1\frac{7}{10}$ inch.

Hab. Talaut Island, south of the Philippines (*Doherty*).

The genitalia is somewhat similar to that of *A. migrator*, Walker, from Australia (type from Moreton Bay, Queensland, in B.M.). I have it from Rockhampton, Queensland, but the colour of the insect is very different. *A. migrator* is quite distinct from *A. transversa*, Guen., from India, of which Hampson makes it a synonym.

Pl. VIII. fig. 8 *talauta*, fig. 9 *migrator*.

Family **Catocalidæ**.

Enmonodia padanga, nov.

♂. Purple-brown tinged with pink, head and collar dark brown; thorax purplish grey with a brown stripe down each side; abdomen with the basal half grey with brown segmental bands, the anal half crimson with brown segmental lines: fore wing with the costal and basal spaces and a smear in the disk purplish grey, the rest of the wing dark purplish brown; a dark brown stripe from the apex to vein 5; an angulated black line down the disk to the hinder margin, outwardly lined with purple-grey (somewhat obscure); a subterminal row of black lunules; an inverted comma-shaped discoidal mark composed of fine black rings, its inner end with an oval black spot attached to its outer side: hind wing uniform purple-brown, a postmedian pinkish-grey transverse line composed of conjoined acute angles. Underside uniformly ochreous-scarlet: fore wing with the costa brown; a large round brown spot in the middle of the cell, two brown bars closing the end; three angulated thick brown outwardly-curved lines close together across the middle; a broad brown transverse band on a pale brown space in the outer marginal space: hind wing with a brown lunule in the cell; the three centre thick lines as in the fore wing, but more widely separated from each other, the marginal space as in the fore wing.

♀. Brownish ochreous, minutely irrorated with brown atoms; two round black spots encircled with brownish ochreous opposite the end of the cell; a straight double thin dark brown band from the apex, broadening hindwards and extending to near the abdominal margin of the hind wing, the marginal space outside these lines thickly smeared with

brown; a subterminal series of acutely angled white conjoined marks on both wings from the double line hindwards; on the hind wing between the medial band and the white angular series is a brownish shaded band, the outer margin of the wing dark brown. Underside with the ground-colour as in the male, but densely irrorated throughout with brown atoms, two brown bars closing the cell of the fore wing; a medial blackish-brown line across both wings, bent inwards on to the costa on the fore wing; a similarly shaped but angulated post-medial line, a double submarginal line, the inner one thickened towards the costa of fore wing, and a thin row of black lunules close to the margin; cilia of both wings black.

Expanse of wings, ♂ 3, ♀ 3½ inches.

Hab. Padang, Sumatra.

Anua clementi, nov.

♀. Head, thorax, and fore wing clear ochreous grey; fore wing not irrorated as in most of the species of this group, but striated with grey over the entire wing, the fine striations quite clear throughout and more numerous towards the outer margin; a hardly visible ear-shaped mark at the end of the cell, an angulated black spot on the costa beyond the middle, from its point an outwardly curved, waved, faint grey line runs to near the middle of the hinder margin, where it is bluntly angled and runs up to the costa one-fourth from the base; a broad brown diffused band down the wing one-fifth from the outer margin, angled outwards below the costa, where it is darkest, then somewhat acutely angled inwards and again outwards; cilia brown: hind wing bright ochreous yellow, a broad black discal band, not reaching the hinder angle and suddenly narrowing before reaching the costa near the apex. Underside greyish ochreous: fore wing with a very large lower discal black patch: hind wing with a pale discal brown band, blackish on the costa, and enlarged and black at its lower extremity, which does not reach the hinder angle.

Expanse of wings, ♀, 3 inches.

Hab. Roebourne, Sherlock River, Australia (*Clement*).

The black band of the hind wing in the type-specimen is much broader than in the others. I have three examples, all females; I can find no striations on the fore wing of any of the long series in my collection of this group. I have seven species, there is no black spot, angulated or otherwise, in the centre of any of them.

Ercheia anvira, nov.

♂. Head, body, and fore wing pinkish brown: fore wing with a pale brown stripe below the middle running from base to outer margin; transverse lines brown, subbasal; short antemedial and medial; the postmedial line bends outwards from the costa in a circle, is bent abruptly inwards below and then straight to the hinder margin; all these lines are sinuous and double; a brown subapical patch in the costa, reniform, ear-shaped, pale, and on a small brown patch; terminal line crenulate; cilia pale with brown tips: hind wing black, greyish towards the base and abdominal margin; a white spot at the end of the cell, one close to the hinder angle, one near the outer margin below the middle; an elongated white spot on the margin below the apex and another above the hinder angle. Underside pale greyish yellow: fore wing with the costa brown; a brown stripe below the middle from the base to the postmedial brown band, which is straight; a broad discal band: hind wing with a small round spot at the end of the cell; a highly sinuous thin median band, a broad irregular-shaped discal band; both wings with small black lunules on the outer margin.

Expanse of wings, ♂ $1\frac{6}{10}$, ♀ 2 inches.

Hab. Kina Balu, Borneo.

Seven males.

Ercheia careona, nov.

♂ ♀. Head, collar, and thorax pinkish grey; thorax with a brown patch in the middle: fore wing dark pinkish black, pinkish-grey irrorations towards the base; the hinder margin broadly pinkish grey, irrorated with pinkish-brown atoms, this feature less strongly defined in some of the females; a submarginal pinkish-grey line and some pinkish-grey irrorations on the margin: hind wing black, paling somewhat towards the base and abdominal margin; a large white spot at the end of the cell, connected with another near the hinder margin; a long white mark on the outer margin below the apex, and another behind the hinder angle. Underside much as in *anvira*, but the bands are broader.

Expanse of wings, ♂ $1\frac{1}{2}$, ♀ $1\frac{9}{10}$ inch.

Hab. Kalao Island, near Celebes.

One male and five females.

Ercheia enganica, nov.

♂ ♀. Head and body greyish brown: fore wing with the ground-colour brownish pink, irrorated with brown; a triangular black basal patch, edged with white, its lower side limited by vein 1, containing three ochreous costal dots and a subbasal ochreous basal line, the outer lower portion of the wing more densely irrorated; a short white line on the disco-cellulars, a white dot above it, another outwardly below it; a thick black lunular spot, outwardly pale-edged, in the middle of the first interspace, another beyond it with a black sinuous line, outwardly edged with white, connecting it with the hinder margin; a large black patch on the costa extending to the apex, a white submarginal line running through it and continued with an outward curve to the hinder margin; an indistinct series of black lunules on the margin; cilia brown: hind wing black, slightly paling towards the base; a large white spot at the end of the cell, a smaller one near the middle of the outer margin, and a still smaller one near the hinder angle; a long white streak on the outer margin below the apex. Underside pale yellowish on basal half, then black to the outer margin; a broad white postmedial band narrowing hindwards, a white patch at the apex and halfway down the margin: hind wing with a black spot at the end of the cell; an antemedial outwardly curved thin black band, followed by a white band; the outer half of the wing black, with a thin white band running through it; a white streak on the margin below the apex; a spot on the middle and another near the hinder angle.

Expanse of wings, ♂ 1½, ♀ 2 inches.

Hab. Engano Island, near Sumatra.

Two males and one female.

Genus BASTILLA, nov.

Belongs to Hampson's first section of his genus *Parallelia*; mid-tibiæ of male dilated, with a groove containing a fringe of large scales; hind tarsi of male with the first joint fringed with hair above at base; fore wing with the costa lobed before middle.

Type, *Bastilla reduncа*, Swinhoe, Cat. Het. Mus. Oxon. ii. p. 141 (fig.) (1900).

Dysgonia manilluna, nov.

♂ ♀. Head and thorax greenish brown; abdomen greenish

grey with thin segmental brown lines: fore wing with the basal third greenish brown, blackish towards the antemedial line, where it gradually becomes nearly pure black and is outwardly edged with white; a broad white medial band minutely irrorated with grey; a black discal band, its inner side suffused and thickly joined along the costa to the antemedial line, its outer side angled outwards below the costa and again at its middle, then curving and narrowing inwards to the hinder margin and edged with white; the outer portion of the wing pale brown with a darker shade running through it, ending in an apical black patch with its inner side suffused, its outer side dentated, some dark suffusion at the outer margin: hind wing with the basal third pale brown, a medial white band, darker brown outside it, some white suffusion at the middle of the outer margin; a thin brown marginal line on both wings; cilia of fore wing pale brown, of hind wing white with some pale brown on its lower part. Underside brownish grey; a broad, diffused, discal, brownish band on both wings with the outer margin whitish.

Expanse of wings, ♂, $1\frac{3}{10}$ inch.

Hab. Manilla, Philippines.

Dysgonia fruhstorferi, nov.

♂. Head and body grey-brown: fore wing with the basal third grey-brown; a broad medial white band rather thickly irrorated with minute grey atoms, especially on the upper and lower ends, the band evenly inwardly curved on both sides, edged with black on the inner side and with a large triangular black patch on the outer side, its outer edge from the costa a little apart from its inner edge, curved into an acute point, then slightly curved inwards and narrowing to a point on the hinder margin, slightly edged with white from the costa to the point, four white costal dots between it and the apex, a brown shade from the apex running down the outer side of the black patch followed by a whitish shade, the outer margin brownish and two black angular spots at the apex, the upper one encircled with white, the lower one edged with white at its outer side; small black marginal spots and cilia; altogether more or less of the *stuposa* pattern: hind wing grey-brown, faint indications of a thin greyish band down the middle and greyish on the middle of the outer margin.

Expanse of wings, ♂, $2\frac{1}{10}$ inches.

Hab. Fergusson Island, Papua (*Fruhstorfer*).

Chalciope saima, nov.

♂. Antennæ and palpi grey-brown, the latter black at the sides; face and pectus greyish ochreous, the latter with a black stripe on each side; legs ochreous grey marked with black; head, body, and wings ochreous brown: fore wing with the inner portion filled in by a very large black elongated triangular patch, edged with whitish, its upper and lower sides almost straight, its outer edge slightly evenly inwardly curved, leaving the margins narrow, its upper point very acute and nearer the apex than it is even in *C. cephise* of Cramer; an oblique narrow white band through its middle, open at both ends, the ends slightly irrorated with brown, some black points on the outer white lining of the black patch, the outer margin brown; the cilia brown with a pale inner line; some whitish suffusion on the hinder margin: hind wing dark brown; a faint, narrow, grey band not nearly reaching either the costa or the hinder angle, where there is a little pale suffusion; cilia grey.

Expanse of wings, ♂, $2\frac{2}{10}$ inches.

Hab. Nias.

Allied to nothing I know of; the largest species of the genus I have yet seen.

Hypætra minima, nov.

♀. Palpi dark brown at the sides, whitish beneath, the tips of last joints white; head, body, and fore wing uniform chocolate-brown: fore wing with a deep black subbasal quadrate patch with pale edgings close to the hinder margin, excavated on its upper and lower sides, a brownish patch between it and the costa; a curious hook-shaped deep black mark at the end of the cell, its upper part thickened and quadrate, a brownish patch between it and the costa, another brownish patch on the costa before the apex, and a small one at the apex; a series of minute black dots on the outer margin: hind wing chocolate-grey, a little paler basally, no markings; cilia of fore wing pale chocolate-brown, of the hind wing slightly paler than the wing-colour, two whitish subapical spots on it and another at the hinder angle. Underside: fore wing greyish brown, hinder margin white, cilia grey: hind wing pale greyish brown, the outer margin broadly darker, cilia white, greyish at the tips.

Expanse of wings, ♀, $1\frac{8}{10}$ inch.

Hab. Luzon, Philippines.

Family **Erebiidæ**.

We cannot believe that the genus *Argiva* and its allies can belong to the family Catocalidæ. It seems to us that *Argiva* has no relation whatever to the genus *Catocala*; their structure is completely different; they have enormous black densely hairy extensile organs ("coremata") upon the dorsal surface of the tegumen, almost hiding the armature of the delicate valves. These alone confirm, by the absence of the large scaptilum of *Catocala*, that the relationship is mistaken. Pl. X. fig. 20 shows the genitalia of *Argiva hieroglyphica* (the type of *Argiva*), fig. 21 that of *fraxini*, Linn. (the type of *Catocala*), copied from Pierce's 'Genitalia of British Noctuidæ,' fig. 23 that of the common European species, *nupta*, Linn.; note the entire absence of the coremata and the asymmetry of *nupta*, which is usual in *Catocala* and its relatives.

The habits of life of such of the species as are known to me are entirely different to those of the Catocalidæ; they are crepuscular and mostly cave-dwellers, very quick and sharp in their short flights, the males darting forwards and attacking those that pass, much after the manner of some of the butterflies of the family Nymphalidæ. This is particularly the case with *Patula macrops*; I have watched them in the caves of the Island of Elephanta in the Bombay Harbour.

Genus ARGIVA, Hübner.

The genitalia of the different forms of *Argiva* are very similar; the differences are so slight, they may arise from mounting. I give the figure of the costa of *A. hieroglyphica*, the type of the genus (text-fig. 15). There appears to be no difference in any of the mounts except the "costa," which varies slightly under different names.

Argiva lunaris.

Bocana lunaris ♀, Walker, xxxi. 57 (1864).
Nyctipas hieroglyphica, Hampson (part.), Phal. xii. p. 275 (1913).

Hab. Celebes, Gilolo.

A perfectly distinct species, sexes alike. I have both sexes from N. Celebes and Gilolo (text-fig. 18).

Argiva sumbana, nov.

♂. Much like the male of *lunaris*, but the subapical yellowish-white bar is not continuous, but is shorter even than in *hieroglyphica* and is broken into two pieces. Underside paler; two large subapical spots, well separated, another in the middle of the disk.

♀. Fore wing with the basal two-thirds ochreous brown, the outer third black-brown, the comma-shaped discoidal mark as in the male; the subapical bar white and short,

Fig. 15. Fig. 16. Fig. 17.

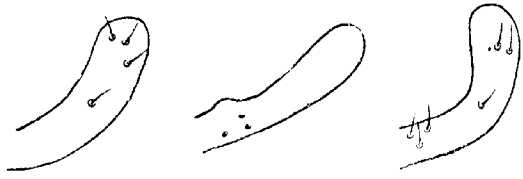

Fig. 18. Fig. 19

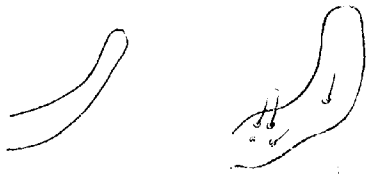

Fig. 15.—*hieroglyphica*. "Costa" more parallel sides.
Fig. 16.—*sumbana*. "Costa" perhaps running narrower.
Fig. 17.—*luzonica*. "Costa" perhaps more curved.
Fig. 18.—*lunaris*. "Costa" appears narrower, but hardly in the same plane.
Fig. 19.—*ceramica*. "Costa" somewhat differently shaped.

consisting of three attached spots, the two lower ones large, the upper ones small; no other markings; hind wing similarly coloured, and with a large white upper discal spot. Underside paler and more ochreous, the spots ochreous white; the subapical spots as above, but not connected; a discal row of large spots across both wings; the middle spot in the fore wing and the second upper spot in the hind wing pushed outwards.

Expanse of wings, ♂ 3, ♀ $3\frac{1}{10}$ inches.

Hab. Sumba Island (*Doherty*) (text-fig. 16).

Argiva luzonica, nov.

♂. Brown-black, the inverted comma-shaped discoidal mark very indistinct, without any distinguishing blue or white scales; the subapical streak very narrow, little more than a thick sinuous line, the colour dark chrome-yellow: hind wing unmarked. Underside paler, the subapical streak thicker and ochreous white, separated into two pieces; a faint small ochreous-white spot in the middle of the disk; hinder marginal spot suffused greyish.

Expanse of wings, ♂, 3 inches.

Hab. Luzon, Philippines (text-fig. 17).

Argiva ceramica, nov.

♂. Black-brown, the inverted comma-shaped discoidal mark very obscure, hardly traceable; the subapical streak more curved than in the other forms, slightly thickened on the costa, but otherwise of fairly even width, ending in a point quite close to the outer margin; colour ochreous white; no other markings. Underside paler, the subapical streak similar; the hinder marginal space of the fore wing slightly suffused with grey.

♀. Fore wing with the basal two-thirds ochreous brown, the ring of the discoidal mark the only distinct part of this mark, its tail well separated from its beginning and connected with a highly curved black line to the hinder margin; the outer third of the wing dark brown; the subapical streak broad, narrowing hindwards, its end blunt and not reaching the outer margin; a large white spot in the middle of the disk: hind wing with the basal half dark brown, the outer half ochreous brown, divided by a series of indistinct whitish marks. Underside paler; both wings uniformly coloured, except that the hinder margin of the fore wing is slightly greyish; the subapical streak and discal spot as above; a minute whitish spot in the upper disk of the hind wing.

Expanse of wings, ♂ 3, ♀ 3½ inches (text-fig. 19).

Hab. Ceram Island.

Genus CARIONA, nov.

Differs from the genus *Patula* in having the hind wing normal, the neuration normal. In *Patula* the costal half is aborted, and forms a fold turned over on the upper surface containing a large glandular patch, making the veins aborted. Section III. B. of Hampson's genus *Nyctipao*, Phal. xii. p. 286 (1913).

Type, *albicincta*, Kallar.

Genus Erebus.

Erebus variegata.

Nyctipao variegata, ♂, Butler, Ann. & Mag. Nat. Hist. (5) xiv. p. 432 (1887); Hampson (part.), Phal. xii. p. 296, pl. 206. fig. 6, ♂ (1913).

Hab. Solomons.

N. caliginosa, Butler, *l. c.* p. 433, which Hampson makes the female of *variegata*, is a distinct species; it is not the female of *variegata*. I have the true female of *variegata*, also from the Solomons (from Shortland Island); it is very similar to the male, has more white suffusion in the wings, and is much larger.

Erebus ephesphoris.

Phalæna noctua crepuscularis, Cram. Pap. Exot. ii. p. 99, pl. 160. fig. A (1779) (nec Linn.).
Nyctipao ephesphoris, Hübner, Verz. Schmett. 272, 2675 (1827).
Nyctipao ephesphoris, Walker, xiv. 1305 (1858).
Nyctipao leucotænia, Guen. Noct. iii. p. 184 (1852); Hampson, Phal. xii. p. 298, pl. 207. figs. 7 ♂, 8 ♀ (1913).

Hab. Amboina.

I have one male and three females from Amboina which are undoubtedly identical with *leucotænia* and with Hampson's excellent figures. The type came from Amboina.

Erebus saparœa, nov.

♀. Chocolate-brown, tinged with ochreous: fore wing with indications of a subbasal band; a rather broad sinuous antemedial brown band from costa to hinder margin, followed by a similar band a little before the middle, outwardly edged with greyish ochreous from the hinder margin to the whorl-shaped discoidal mark, which is very large; its black ring strongly outwardly edged with white, which thickens on the costa and has a billhook-shaped large centre filled in with brownish ochreous, ringed with deep black, and edged inwardly and outwardly with white; a brown thin even discal band with a slight outward curve from the costa to the outer margin, followed by a pale and more ochreous space; the other third of the wing as dark as its basal portion; a large subcostal white spot before the apex, oval and excavated on its outer side, a small white lunule immediately below it, followed by five white lunular marks inwardly edged with black down the disk—the first minute, the fourth well outwards, the row ending in an outwardly-curved white line close to the hinder margin; cilia brown with white spots at

the interspaces in the lower two-thirds of the wing: hind wing with two bands in continuation of the third and fourth bands of the fore wing, the pale ochreous-tinged space extending almost to the outer margin; a large oval subapical white spot and a row of six white lunules, three and three in echelon. Underside paler and more ochreous; a black and white discoidal lunule on each wing; the subapical and lineal spots as above.

Expanse of wings, ♀, $4\frac{4}{10}$ inches.

Hab. Saparæa, Celebes.

Erebus niasana, nov.

♂. Chocolate-brown; head and thorax dark brown; abdomen brownish grey, the first two segments filled in with black-brown, nearly pure black, the next pale grey, the rest of the abdomen darker grey: fore wing with a thick white line, a thin band from the hinder margin one-fourth from the base obliquely towards the apex curling round the discoidal whorl-shaped mark, its outer side before it begins the curl broadly pale grey, extending in a subdued form to the apex of the wing, with some pure white patches outside the band; the ground-colour of the wing above this band very dark chocolate-brown; the black ring round the discoidal mark sinuous, the inner portion is black and confused, outwardly ringed with dull brownish ochreous; a large triangular white subapical spot; some indistinct blackish discal lunules, one or two of them pricked with white: hind wing with the pale grey band of the fore wing continued subbasally, followed by a thin dark brown band; a medial band, an ochreous-grey discal shade with black spear-shaped marks on its outer side; a subapical white lunule and an indistinct submarginal lunular line. Underside with the basal two-thirds pale and ochreous-tinged; fore wing with a subapical white spot and three in the disk; hind wing with a subapical small spot.

♀. Paler than the male; the medial pale grey band obscure; a whitish slightly sinuous line across the disk of the fore wing edged with brown, and continued across the middle of the hind wing; a large subapical spot on the fore wing, with five discal white lunules, outwardly edged with black, the third and fifth with the white only indicated on the hind wing; there is an antemedial band, a white subapical lunule, and a discal row of black lunules inwardly edged with white. Underside as in the male.

Expanse of wings, ♂ $3\frac{8}{10}$, ♀ $4\frac{2}{10}$ inches.

Hab. Sitoli, Nias.

Erebus malanga, nov.

♂. Head and thorax dark brown; abdomen grey with whitish and dark grey segmental bands, the first two segments black-brown: fore wing with the central band broad throughout, slightly curved, and ochreous white until it is sharply angled round the discoidal whorl-shaped mark, the upper part from the angle to the costa quite white; the black ring of the whorl is correspondingly sharply angled, its inner side inwardly edged with white, the centre portion very obscure; the bill-hook is greyish pink ringed with black, and this colour runs right round the centre portion; all the upper portion of the wing is very dark, the subapical spot is fairly large, triangular, its lower point blunt, a small white dot outwards below it, followed by an irregular row of five white lunules outwardly edged with black, the first a double lunule, the lower lunules in a black suffusion, and a black angular patch outwardly edged with white on the hinder margin against the middle of the central band: hind wing with antemedial and medial blackish bands outwardly edged with ochreous grey; a subapical white lunule; a much curved and recurved black lunular discal line inwardly edged with whitish ochreous, greatly protruded outwards in its middle, with a blunt square and ochreous suffusion on each side and a blackish suffused patch below the subapical lunule. Underside pale brownish ochreous, the outer marginal space suffused with brown: fore wing with a whorl of whitish spots round the outside of the cell; a subapical spot, seven discal spots, the fifth well outside: hind wing with a black spot in the cell, two indistinct outwardly curved brownish lines in the middle; a subapical white lunule, a small white dot below it; a discal black lunular line, disposed as on the upperside.

♀. Very similar to the male.

Expanse of wings, ♂ $4\frac{1}{10}$, ♀ $4\frac{3}{10}$ inches.

Hab. Malang, Java.

Erebus philippensis, nov.

♂. Chocolate-brown, tinged with ochreous: fore wing with a thin obscure whitish line from the basal fourth of the hind wing running towards the apex, but not continued beyond the whorl-shaped discoidal mark, which it curves round and thickens somewhat towards the costa; the space above this line dark brown to the apex, but the portion beyond the whorl is without the white line; the whorl line is black as

usual; on the inner side inside the black line is a narrow pinkish-ochreous stripe, its lower end curved and broadened, and joining a large black patch; a thin greyish-ochreous middle line edged with black across the wing, with a small outward angle at its middle; a blackish suffusion on the lower disk; a subapical white rather large spot and four discal white spots in an irregular row, outwardly edged with black: hind wing with the base dark brown; an antemedial brown line with a pale outer edging; a medial somewhat crenulate greyish-ochreous line in continuation of the middle line of the fore wing; a subapical white spot; a discal indistinct greyish-ochreous line, more or less lunular, the hollows of the lunules filled in with black, the row deeply curved above its middle and then deeply and bluntly outwardly angled below its middle; body concolorous with the wings; the first two segments of the abdomen black, the third pale grey. Underside ochreous brown, the outer half dark, limited by a brownish hin band across both wings; the discal markings disposed as on the upperside, the white spots larger.

♀. Brown with a lilac tinge; abdomen with the first two segments black; wings of a uniform colour, the upper dark portion of the male only slightly indicated except towards the apex, which is dark; the whorl-shaped discoidal mark as in the male; a broad white band across both wings, broadest on the hind wing, its outer side with points like a fringe; the discal markings as in the male. Underside pale ochreous brown; the medial white band macular on the fore wing, broad on the hind wing; the discal markings as on the upperside.

Expanse of wings, ♂ 4, ♀ $4\frac{4}{10}$ inches.

Hab. Cape Engano, Luzon, Philippines.

Genus PATULA, Guen.

Patula does not possess the two curious chitinous plates in the connection between the 8th and 9th abdominal segments found in *Argiva*; Pl. XI. figs. 24, 25, 26, & 27 show the genitalia of the true *P. macrops*, drawn on the same plane as in the figure of the genitalia of *Argiva*. In the development of the coremata it agrees with *Argiva*; the structure of the valve and the shape of the penis are the chief points. The hind wing of the male has the costal half aborted, forming a fold turned over on the upper surface, containing a large glandular patch of flocculent hair; vein 4 runs to the functional apex, 5 from the middle of discocellulars, 6 to the fold, 7 and 8 very minute to near base of centre.

Patula moriola, nov.

♀. More or less similar in pattern to the common Indian species *P. macrops*, Linn., but the antemedial line ends hindwards in two conjoined rings, the lower one touching the hinder margin; it is a smaller insect, much paler in colour, without the purplish glow of *patula*, the brown colour having a distinct ochreous tinge; it certainly cannot be the female of *P. macfarlanei*, which Hampson says is also to be found in Amboina, though the type came from Cape York in Australia, the markings being very different.

Expanse of wings, ♀, $5\frac{2}{10}$ inches.

Hab. Amboina Isl.

Patula oxdoxia, nov.

♂ ♀. Also very similar in pattern to *P. macrops*, but the outer transverse sinuous lines are farther apart on the fore wing and the submarginal line of the hind wing is not nearly so sharply doubled; it is a very large *Patula*, larger even than *macrops*, and the colour is quite different, being paler and more ochreous even than *moriola*. The genitalia, as might be expected, also differs from that of *macrops*; the valves of *P. macrops* are much broader, the penis is also different, there are larger bunches of cornuti and chitinous red, and the sacculus of the valves is much more developed (Pl. XI. figs. 26 & 27).

Expanse of wings, ♂ $6\frac{2}{10}$, ♀ $5\frac{5}{10}$ inches.

Hab. Alu Island, Solomons, a small island close to Shortland Island.

Two males, four females.

Patula ipsa, nov.

♂ ♀. Very similar in pattern to *macrops*, but paler in colour and is a smaller insect; the genitalia is also different; the penis agrees somewhat with that of *macrops*, but the valves are much narrower; the difference is shown in the Pl. XI. fig. 25.

Expanse of wings, ♂ 5, ♀ 5–$5\frac{1}{2}$ inches.

Hab. Kandy, Ceylon.

Family **Noctuidæ**.

Brevipecten promona, nov.

♂. Palpi white beneath, dark brown above; antennæ

grey; head, body, and fore wing dark grey, the ground-colour being white, thickly irrorated with dark grey atoms; thorax with a brown stripe down each side: fore wing with the lines darker grey, subbasal, from the costa to vein 1 indistinct; antemedial line slightly oblique from costa to hinder margin; medial line similar, its upper part lost in a large jet-black patch from the costa, its inner side deeply excavated and edged with white, a grey line closing the cell; postmedial line outwardly oblique from the costa, acutely angled and inwardly oblique to the hinder margin close to the termination of the medial line; marginal line crenulate, some brownish suffusion on the margin; cilia greyish brown: hind wing pale grey, whitish towards the base and abdominal margin; terminal line dark grey; cilia white on the lower half, grey upwards, intersected by a grey line. Underside: both wings evenly pale grey; a white subapical small patch on the fore wing, with a black spot on its inner side, which is in continuation of an indistinct grey discal transverse line.

Expanse of wings $1\frac{4}{10}$ inch.

Hab. Cape York, N. Queensland (*Dämel*).

Has some resemblance to *B. captatus*, Butler, from India, of which I have both sexes.

Capnodes asulca, nov.

♀. Head, body, and wings dark pinkish brown, very uniform in colour throughout: fore wing with a black spot in the cell and four in a cluster at the end; a curved dark mark on the costa near the apex, with a disjointed white streak on its inner half; a discal transverse sinuous row of white dots from the inner end of the streak across the wing, each dot with a black dot on its inner side; a row of subterminal black dots: hind wing with a discal row of similar white and black dots and subterminal black dots. Underside paler; a discal indistinct thin band and subterminal black dots on both wings; cilia brown.

Expanse of wings, ♀, $1\frac{4}{10}$ inch.

Hab. Khasia Hills.

Diomea nasea, nov.

♂. Very dark olive-brown, nearly black, very uniform in colour; palpi white on the inner sides, a white stripe on each shoulder; thorax and both wings with numerous round white spots: fore wing with costal spots at equal distances apart, with minute dots immediately below them; transverse rows

of basal, antemedial, postmedial, and submarginal spots and some medial white specks, the postmedial row consisting of three rows, the others of two rows and a marginal series; hind wing with indications of a medial white line and many white spots covering the outer half of the wing: legs with white bands.

Expanse of wings, ♂, $1\frac{3}{10}$ inch.

Hab. Kuching, W. Borneo.

Oræsia camaguina, nov.

♂. Palpi brown; head and collar orange; thorax and fore wing dark ochreous brown; very dark and uniform in colour on the fore wing, making the markings very obscure and difficult to trace; a darker streak on the median vein; an oblique straight double line from apex to hinder margin, its upper half filled in with pale dull ochreous, a narrow brown shade from its middle to the lower end of the cell, then in a straight line to the middle of the hinder margin; two white ochreous patches on the outer margin, in its middle and at the hinder angle touching each other; cilia dark brown: hind wing white, the veins and streaks in the interspaces pale grey.

♀. Much as in *O. emarginata*, Fabr., from the Indian region, but all the markings on the fore wing more or less obscure.

Expanse of wings, ♂ $1\frac{2}{10}$, ♀ $1\frac{6}{10}$ inch.

Hab. Camaguin Island, near Manilla, Philippines (*Semper*).

Genus SERICIA.

Sericia, Guen. Noct. iii. p. 172 (1852), type *spectans*, Guen., from Australia.

Spiredonia, Hampson, Moths India, ii. p. 457 (1894) (nec Hübner).

Sericia sumbana, nov.

♂ ♀. Fore wing narrow, much narrower than in any other species of this genus; upperside with the ground-colour pinkish grey, suffused in parts with pinkish brown; markings much as in the common Indian species, *S. zamis*, of Cramer; the discal ocellus filling the lower curve of a figure of ε, small: hind wing of the same pinkish-grey ground-colour, with the usual familiar markings. Underside much paler and brownish grey.

Expanse of wings, ♂ ♀, $2\frac{6}{10}$ inches.

Hab. Sumba Island, south of Flores Island in the Timor Sea (*Doherty*).

I have four males and one female of this very distinct form.

Family **Hypenidæ**.

Genus GLOBOSUSA, nov.

♂. Antennæ unipectinated, palpi long and somewhat upturned, the first two joints thickened and with stiff paired bristles, the last joint very slender, with bristles before its end; top of head with short thick hairs which protrude somewhat in front; all the legs naked, with very long spurs; both wings rounded in a circular form: fore wing broad, costa and hinder margin straight, cell broad, discocellulars nearly straight; vein 2 from a little beyond the middle of the cell, 3 from about halfway from it and the cell-end, 4 and 5 from the end; 6, 7, 8, and 9 deeply curved, 6 from upper end, 7, 8, and 9 stalked: hind wing with vein 2 from the middle of the cell, 3 and 4 on a short stalk, 5 from the cell-end, 6 and 7 from the upper end, 8 free, recurved, touches 7 near its base.

Type, *G. curiosa*, mihi.

A very curious-looking moth.

Globosusa curiosa, nov.

♂. Antennæ grey, palpi blackish brown, legs yellow striped with black on the upperside; head, thorax, and fore wing saffron-yellow: fore wing with faint indications of subbasal, antemedial, and postmedial grey lines; a blackish postmedial patch on the costa and black dots on the outer margin: hind wing yellowish white, indications of a recurved medial grey line, its lower part with black spots on veins 3 and 2 and two near the abdominal margin; indications of a postmedial outwardly curved grey line and black lunular spots on the outer margin. Underside uniform yellowish white; fore wing with a linear black spot in the cell, a smaller one at the end, small postmedial and subapical brownish marks; hind wing with a small lunular discoidal black spot.

Expanse of wings, ♂, 1 inch.

Hab. Saugir Island, south of the Philippines (*Doherty*).

Bertula adra, nov.

♂. Upperside: head, thorax, and fore wing dark olive-brown; traces of antemedial, medial, and postmedial outwardly curved, somewhat sinuous brown lines; a submarginal straight white line inwardly edged with dark brown from the costa near the apex to the hinder margin close to the angle; hind wing brownish grey, a faint brown lunule at the end of the cell; traces of a medial outwardly curved brownish line; a white submarginal line from close to the hinder angle, angled outwards, then crenulate upwards, and becomes obsolete before reaching the costa. Underside grey: fore wing with some brownish suffusion on the upper part, whitish along the hinder marginal space; a postmedial, outwardly curved, crenulate brown line; a straight brownish submarginal line; the outer portion of the wing whitish: hind wing white, thickly irrorated with brown atoms; a brown lunule at the end of the cell; two outwardly curved crenulate brown lines, outwardly edged with white, corresponding to the two lines on the fore wing.

Expanse of wings, ♂, 1 inch.

Hab. Jaintia Hills, Assam.

Genus WILKARA, nov.

♂. Antennæ simple; palpi upturned, very long, second joint very long, rising much above the head, densely hairy, third joint concealed by the hairs; hind legs with the tibiæ densely hairy, the tufts of hairs extending, reaching halfway down the naked tarsi; thorax crested; abdomen smooth: fore wing narrow, costa nearly straight, apex somewhat rounded, outer margin convex, hinder angle somewhat rounder, hinder margin slightly convex: hind wing with the costa straight, apex and hinder angle rounded, outer margin nearly straight: fore wing with vein 2 from the middle of the cell, 3, 4, and 5 from the lower angle, 6 and 7 from upper angle; a long brush of stiff straight hairs from the subcostal vein crossing the upper end of the cell, with some shorter similar hairs beyond it: hind wing with vein 2 from before the middle of cell, 3, 4, and 5 from the lower end, 6 and 7 from upper end, 8 free.

Type, *W. nigerrima*, nov.

Walkara nigerrima, nov.

♂. Upperside dark uniform black, with a slight lilac tinge: fore wing with a small white dot in the middle of the cell, a white spot at the end; a brown, nearly erect, antemedial line, a white subapical costal dot, a black apical spot; an oblique, straight, brown, thick line from this spot right across both wings, outwardly edged with whitish, to the abdominal margin of the hind wing beyond the middle. Underside: fore wing coloured like the upperside, the costal space above the subcostal vein pinkish grey, the outer veins streaked with pinkish grey; the brush of hairs grey: hind wing black, the abdominal space pale.

Expanse of wings $1\frac{4}{10}$ inch.

Hab. Kalim Bungo, Central Nias. (*Kannegieter*).

Bomolocha olypea, nov.

♂. Head, body, and wings dark pinkish grey: fore wing with the costal line black; a large medial black patch across the wing, its inner edge upright but bent inwards a little on the costa, its outer edge from one-sixth from the apex with many outward dentations to vein 3, then with a slight inward curve obliquely to the hinder margin a little beyond the middle; no other markings on either wing. Underside pale uniform brownish grey, fore wing with some blackish suffusion on the basal half.

Expanse of wings, ♂, 1 inch.

Hab. Mahableshwar, Bombay Presidency.

Bomolocha commixtura, nov.

♂. Upperside olive-brown; the ground-colour is really whitish, but the whole surface of both wings is densely irrorated with olive-brown atoms: fore wing with a black discoidal spot; traces of a whitish, outwardly curved, antemedial line; a postmedial white line, inwardly edged with black, outwardly oblique and incurved below the costa, then slightly sinuous, straight down with a slight incurve to vein 2, then with smooth inward curve to the hinder margin beyond the middle; traces of a white sinuous submarginal line; a white marginal lunular line outwardly black-edged; cilia with indistinct white inner line: hind wing paler; an indistinct, whitish, outwardly curved, postmedial, sinuous

line, the outer margin marked like it is on the fore wing. Underside brownish grey, with some greyish-white streaks in the interspaces.

Expanse of wings, ♂, $1\frac{2}{10}$ inch.

Hab. Lombok Island, between Bali and Sumatra.

Bomolocha variegata, nov.

♀. Palpi and head greyish ochreous, thorax greenish brown, wings greyish ochreous: fore wing with the costal line greenish brown, a patch of that colour in a triangular form filling the cell and the basal part of the next lower interspace; the outer part of the wing similarly coloured, an apical curved ochreous-grey streak in it which joins the ochreous-grey space between, the hinder portion of the wings ochreous grey; marginal line brown, crenulate, and with white points; cilia ochreous grey: hind wing without markings, the margins as on the fore wing. Underside ochreous grey, as also are the body and the legs: fore wing with a white spot at the end of the cell and two subapical white spots, the latter nearly obsolete in the type-specimen.

Expanse of wings, ♀, $\frac{9}{10}$ inch.

Hab. Kina Balu, N. Borneo.

Bomolocha uniformis, nov.

♂. Palpi, head, thorax, and fore wing dark greyish ochreous; a blackish discoidal spot, no other markings: hind wing grey, also without markings. Underside: body, legs, and wings uniformly grey, no markings except for an indistinct darker grey discoidal spot on each wing.

Expanse of wings $1\frac{3}{10}$ inch.

Hab. Jaintia Hills, Assam.

Family **Nymphulidæ**.

Dracœnura arfakalis, nov.

♂ ♀. Palpi brown, white beneath; collar grey; head, thorax, and fore wing dark purplish brown: fore wing with the veins blackish; a black spot in the cell and another at the end, no other markings: hind wing pure white; a brown marginal band with irregular inner margin, thickened some-

what at the apex: abdomen with the basal half grey, with some white on the segments; anal half black, tuft white. Underside: fore wing paler, a black discoidal spot; hind wing as on the upperside; body and legs white.

Expanse of wings, ♂ ♀, 1–1$\frac{1}{10}$ inch.

Hab. Arfak Mts., N. New Guinea, 4000′ (*Pratt*).

EXPLANATION OF THE PLATES.

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IV.—*Some Mediterranean Bryozoa.*

By Arthur Wm. Waters, F.L.S., F.G.S.

[Plate XII.]

In my collection there are many specimens which I have intended to describe or revise, but the description of various large collections has prevented, and I am glad now to make a beginning by dealing with five interesting forms from Naples and Oran:—

Pedicellina hirsuta, Jullien.
Lepralia bifurcata, sp. n.
Lepralia circumcincta, Neviani.
Lepralia oranensis, sp. n.
Lagenipora ignota, Norman.

Pedicellina hirsuta, Jullien. (Pl. XII. figs. 1, 5.)

Pedicellina hirsuta, Jullien, 'Bryozoaires, Mission du Cap Horn,' p. 13, 1888.

The small specimen from Naples seems to correspond with Jullien's description, and has large recurved spines all over the zoœcium, curved and pointed at the base, and their form suggests that they were movable. The peduncle is large and is also covered with spines, while the stolon is much narrower than the peduncle.

In my specimen I am not able to see clearly the base of the peduncle or the adjoining stolon, but believe it is correctly drawn. The contraction near the base has no appearance of being accidental, though more complete material is desirable.

This specimen was referred to in my description of the Red Sea Bryozoa*. It will be noticed that the zoœcium and peduncle are very exceptionally large (calyx about 0·38 mm., peduncle about 0·11 mm.).

Loc. Ile Hoste, Orange Bay, 26 met.; Naples.

Lepralia bifurcata, sp. n. (Pl. XII. figs. 2, 3, 4.)

In specimens from Capri the zoaria have two branches bifurcating at a very wide angle (fig. 2 *a*).

Round the zoarium there are but few zoœcia, from four to eight, either surrounding an imaginary axis or slightly flattened. The zoœcia are irregularly quadrate, granular,

* Journ. Linn. Soc., Zool. vol. xxxi. p. 252 (1910).

having the oral aperture contracted at the side, with the part below the contraction narrower than the part above. At each side of the oral aperture there is a small, raised, rounded avicularium, and any of these may be replaced by a large spathulate one, in one case both avicularia being thus replaced. Usually the spathulate avicularia are directed distally, but one is diagonal, or it may be directed proximally. The bar to the avicularium has a small central denticle.

The granular ovicell is globular, widely open, so that the operculum cannot close the ovicell aperture. At the bifurcation there is a large round opening with a raised border (fig. 3), the object of the opening is not clear. It might have been for a large avicularium, or for a radicle, but the position does not make this probable.

It is much like the fossil *Characodoma halli*, Maplestone *, from Mornington and Mitchell River, Victoria, Australia, which, however, has the quadrate zoarium articulated, and the ovicelligerous zoœcia are surrounded by irregular nodules; however, the shape of the zoœcia is the same with the ovicell in the same position, but in *C. halli* there are small triangular or spathulate avicularia replacing the semicircular or spathuate ones of *L. bifurcata*.

Loc. Capri, 50 fathoms.

Lepralia circumcincta, Neviani. (Pl. XII. figs. 6–10.)

Hippoporina circumcincta, Neviani, "Bri. neoz. di alcune Loc. d'Italia," pt. 3, Bull. Soc. Rom. per gli Stud. Zool. vol. v. p. 118, fig. 7 (1896); Bri. postpl. di Spilinga, p. 28, fig. 11 (1896); "Bri. neog. delle Calabrie," Pal. Ital. vol. vi. p. 187 (73), pl. xvii. figs. 10, 11 (1900).

Lepralia grimaldi, Jull. et Calvet, Bry. de l'Hirondelle, p. 70, pl. ix. fig. 5 (1903).

Cheilopora circumcincta, Levinsen, Morph. & Syst. Stud. p. 353 (1909).

This does not appear to be uncommon at Naples, and Kirchenpauer left a manuscript description in the Zoological Station, calling it *Lepralia dohrni*. When the manuscript was shown to me, it was my intention to describe and figure the species, using the name given by Kirchenpauer, and I have sent away some specimens explaining that Kirchenpauer had given it this manuscript name.

When my paper on the Naples Bryozoa was written it had

* "Further Desc. of Tertiary Polyzoa of Victoria," Proc. Roy. Soc. Vict. vol. xiii. n. s., p. 7, pl. ii. fig. 17 (1900).

not come before me, nor had the specimens first met with any ovicells, but they occur from Oran and from Capri. Neviani evidently had very small pieces fossil and did not describe any ovicell. He speaks of it as incrusting, though with fragments it might be difficult to be certain of this; from Naples and Capri it is unilaminate, whereas from Oran all except one piece are bilaminate, back to back. Jullien and Calvet, in describing *L. grimaldi*, do not say whether it is uni- or bilaminate.

Neviani described the surface as rugose, Jullien and Calvet say with small perforations, and both are correct as regards Capri and Oran specimens, which are covered by large granules and in between there are small pores. The nature of the granules varies in different parts and in some conditions they are the most noticeable, while in others the pores are the most distinct, but none could be described as smooth. The piece figured is very regular, but this is not always the case.

There is a small triangular avicularium at one or both of the upper corners of the zoœcium.

There are about 27 tentacles in the Naples specimens.

There are usually 4 distal multiporous rosette-plates near to the basal wall and 4–6 lateral ones.

The ovicell is coarsely granular, but the granules are not so large as those figured by Jullien and Calvet. It is not raised, but shows beyond the oral aperture buried in the distal zoœcium. The ovicelligerous zoœcia have a much wider oral aperture than the ordinary zoœcia, with the proximal edge straight, while the distal border forms the curve of a wide arc (see fig. 8). The ovicell has much the same shape as that of *Flustra foliacea*, L., passing to the basal wall, the wall between the distal end of the zoœcium and the ovicell does not appear to be calcareous.

It is very difficult to know in which genus this should be placed. Neviani * made the genus *Hippoporina* for all species indicated by modern authors as *Lepralia*—that is to say, all that have a horseshoe-shaped oral aperture; he then mentions *H. pertusa*, Esper, which should therefore be the type of *Hippoporina*. In Part II. of the same paper, also 1895, he mentions *H. foliacea*, Ell. & Sol., and then *H. integra*, sp. n., which he figures. Canu calls this the type, but it is not the first mentioned. In Part III., 1896, Neviani mentions *H. imbellis*, Busk, and *H. adpressa*, Busk; then, further

* "Bri. neoz. di alcune Località d'Italia," 1895, p. 109, and Waters, "Bry. from Zanzibar," Proc. Zool. Soc. 1913, p. 515.

on in the same paper, he describes and figures *H. circumcincta*, nov., and *H. spilingœ*, nov. At one time, through an error in binding, I was misled into thinking *H. circumcincta* was the first mentioned and therefore the type of *Hippoporina*. Neviani also includes *H. edax*, Busk; *H. tessulata*, Rss.; *H. depressa*, B.; *H. complanata*, Norm.; *H. foliacea*, E. & S.; *H. pallasiana*, Moll. Neviani also described the genus as new in "Bri. foss. della Farnesina," Pal. Ital. vol. i. p. 107 (1895), where he mentions first *H. foliacea*, E. & S.—that is to say, in 1895 he described it as new in two places, in one mentioning first *foliacea*, in the other *H. pertusa*. Which of the papers was first published is not indicated, though in Neviani's 'Publicazione Diverse' the "Bri. neoz." comes first.

Canu*, in his "Bryozoaires des Terrains Tertiaires," includes under *Hippoporina* several fossil species, describing or mentioning the ovicells in all but two, but unfortunately his photographs only show them in three cases. *H. angistoma*, Rss., is included, but with its small roundish oral aperture it does not seem closely related to many of the species mentioned by Neviani.

Levinsen† places *circumcincta* in his genus *Cheilopora*, in which some of the species have the ordinary and ovicelligerous zoœcia similar, but in *circumcincta* and *prælucida* the ovicelligerous zoœcia have different and larger oral apertures than the ordinary zoœcia. One of my specimens of *prælucida* with an ovicell is from Tartary‡, and an ovicell has not been referred to by anyone else. It is globular, raised, perforated, and granular, about as wide as the zoœcium, and is not directly closed by the operculum, for, as the ovicell is at a lower level than the operculum, connection with the ovicell is cut off when the operculum closes the oral aperture. The operculum of *L. sincera* has a nearly straight proximal edge with a thickened border parallel to the distal edge, and the operculum of *Cyclicopora prælonga*, Hincks, is very similar, so that it is unfortunate he gave the name *prælonga* to two species which may have to come into the same genus.

At one time the dimorphism, as seen in *circumcincta*, would have been thought sufficient reason for separating it gene-

* Ann. de Paléontologie, vols. ii.–iv. p. 77.

† Morph. & Syst. Stud. p. 353.

‡ The Tartary specimen has avicularia, as figured by Hincks, who, however, says no avicularia; so perhaps he did not recognise that they were avicularia, and in my specimens "from Singapore or the Philippines" there are none.

rically from forms in which it does not occur; but this cannot now be maintained. In Adeonellidæ this difference was made a generic character, but we now see that it only occurs in about half * the species. In *Lepralia* dimorphism is known in *depressa*, B.; *bistata*, Waters; *cincta*, Hincks; *cleidostoma*, Sm.; *circumcincta*, Nev. In *Hippothoa* it is sometimes found, as also in many Catenicellidæ; also in *Caleschara* and *Monoporella waipukerensis*, Waters, in *Cribrilina clithridiata*, Waters, and in *Schizoporella subimmersa*, MacG., &c.

In describing *Lepralia grimaldi*, Jullien says that the dimorphism of the zoœcia in this species is enough to shake our confidence in the characteristic value of the oral aperture, but the reason for this is not clear, for the opercula of the ordinary zoœcia will have the shape of the species both in colonies with or without ovicelligerous zoœcia, and it is therefore a character of the greatest use—besides, in some cases the relationship may also be shown by the ovicelligerous zoœcia.

I am not sure that *Hipporina* will stand as containing the present somewhat heterogeneous collection, nor do I feel at all satisfied with the family Hippopodinidæ, Lev., for *circumcincta* has not a thin-walled zoœcium, the nature and shape of the ovicell is very different in *circumcincta* and *prælucida*, and then the slight difference in the distal wall in *Cheilopora* and *Hippopodina* is a trifling character, the difference in the rosette-plates may or may not be of importance. Under the circumstances I, provisionally, at least, adhere to *Lepralia* of Hincks, and to me it seems that the wisest and simplest thing would have been to have done so generally, and to have gradually removed species to other or new genera when there was sufficient reason for so doing; for as time has gone on it has become clear that many things were incorrectly grouped together under *Lepralia*.

Loc. Naples, 45 fath.; Capri, 30 fath.; Oran, 54 fath. (specimens given by Canu); Bay of Biscay, 240 metres (*J. & C.*).

Fossil. Spilinga, Calabria, post-Pliocene (*N.*); Montelcone, Calabria, Pliocene (*N.*); var., Carrubare, Calabria, Upper Pliocene (*N.*).

* "A Structure in *Adeonella*," Ann. & Mag. Nat. Hist. ser. 8, vol. ix. p. 497 (1912).

Lepralia oranensis, sp. n. (Pl. XII. figs. 11–13.)

The zoarium grows as a hollow cylinder (2–3 mm. diam.), or irregularly, in places forming more than one layer.

The oral aperture is exceedingly long with a marked contraction about the middle, the lower edge being nearly straight or slightly curved upwards, and the distal half of the operculum is very thick, almost semiglobular. On each side of the zoœcium there is a long narrow avicularium, directed distally and extending beyond the line of the aperture. Although there are several specimens, no ovicells have been found. The surface of the zoœcium is irregular, but cannot be called granular, and in the Oran specimens pores are seldom visible, whereas in the Liberia specimens they are more easily followed, there being three or four on the front and some by the avicularium.

There are two distal rosette-plates near the basal wall.

When only some of the tubular specimens had been seen there was thought to be some similarity to *Fedora excelsa*, Jull., but this idea was abandoned on finding more material. There is often a groove-like mark on the dorsal surface.

In a box in Jullien's collection from Petit Tahou, Liberia, there were a considerable number of specimens, together with *Cupularia canariensis* and an erect *Porella*, and specimens therefrom of *L. oranensis* were given to me in the Musée d'Histoire Naturelle, Paris.

Loc. Oran, "zone coralligene," 54 fathoms; Petit Tahou, Liberia.

Lagenipora ignota, Norman. (Pl. XII. figs. 15–17.)

Lagenipora ignota, Norman, "Polyzoa of Madeira," Journ. Linn. Soc., Zool. vol. xxx. p. 309, pl. xlii. figs. 10–13 (1909): Osburn, "Bry. of the Tortugas Islands," Pub. Carnegie Inst. of Washington, No. 182, p. 214 (1914).

The zoœcia are small, and there are very narrow vicarious avicularia placed upon a kind of mound. No zoœcia have been found with two peristomial avicularia, whereas the central peristomial avicularium is well-marked, having a chamber much the same shape as that figured by Savigny for his *Cellepora lancreti*, in which the ovicells are different.

The ovicells have a row of pores within the ridge, as is usual in *Lagenipora*, whereas *L. socialis*, Hincks, to which I have frequently referred *, has a pore at each corner, and as

* Journ. Linn. Soc., Zool. vol. xxx. p. 174 (1907); Proc. Zool. Soc. 1913, p. 511; Proc. Zool. Soc. 1914, p. 858.

this has not been figured a somewhat diagrammatic figure is given (fig. 14). In various species besides the usual row of pores there may be one or two near the centre of the area, and in a specimen from Glenelg, South Australia, the whole of the ovicell area has numerous pores. This last is very closely allied to my *L. caminata*, in which a few pores may be seen between the rows. In *L. costazii*, Aud., besides the usual row of pores at the distal edge of the area, there is frequently another row at the proximal edge, as is also the case in *L. lacinosa*, Calvet, which may be *costazii*, Aud.

The two straight sclerites of the mandible (fig. 16) are quite similar to those of *L. lucida*, and I only know them in these two species and *L. caminata*. Something of the kind occurs in *Thalamoporella rozieri*, Aud.

The oblique peristomial avicularium, figured by MacGillivray in his *Lagenipora nitens*, occurs also in the 'Challenger' *L. bilabiata*, B.; in what has been called *C. granum*; in the *L. lucida*, H.; in *L. diadema*, MacG.

L. ignota, may be only an erect form of *L. lucida*, and there are many cases of *Cellepora* in which the young and the adult forms have received different names. Both have the diagonal peristomial avicularium and the long narrow avicularium.

Loc. Madeira, 70 fath. (*N.*); Tortugas, 12 fath. (*O.*); Oran, 54 fath. From material given by Mons. Canu.

EXPLANATION OF PLATE XII.

Fig. 1. *Pedicellina hirsuta*, Jullien, × 85. *a*, spines, × 250. From Naples.
Fig. 2. *Lepralia bifurcata*, sp. n., × 25. *a*, natural size. From Capri.
Fig. 3. Ditto. × 25. Showing the bifurcation and large round opening.
Fig. 4. Ditto. × 50. Showing an ovicell and two spathulate avicularia.
Fig. 5. *Pedicellina hirsuta*, Jullien. × 12.
Fig. 6. *Lepralia circumcincta*, Neviani. × 12. From Oran.
Fig. 7. Ditto. × 85. Operculum.
Fig. 8. Ditto. × 85. Operculum of ovicelligerous zoœcia.
Fig. 9. Ditto. Lateral wall, showing rosette-plates.
Fig. 10. Ditto. Distal wall, " "
Fig. 11. *Lepralia oranensis*, sp. n. × 25. From Oran.
Fig. 12. Ditto. × 85. Operculum.
Fig. 13. Ditto. × 85. Mandible.
Fig. 14. *Lagenipora socialis*, Hincks. Showing ovicell, somewhat diagrammatic.
Fig. 15. *Lagenipora ignota*, Norman. × 50. From Oran.
Fig. 16. Ditto. × 85. Mandible.
Fig. 17. Ditto. × 85. Operculum.

V.—*Notes on Asteroidea.*—II. By WALTER K. FISHER, Director, Hopkins Marine Station of Stanford University, California.

[Plate XIII.]

The Genus Freyella.—In a revision of the Brisingidæ * recently published in this Magazine, I divided the old genus *Freyella* into two groups, *Freyella* and *Freyellidea*. I made *Freyella spinosa*, Perrier, the type of *Freyella*, since no type was designated originally. The old generic name was retained for those species which are distinguished by having united first adambulacral plates, a syzygial joint between the first and second adambulacral plates, conspicuous proximal marginals, the first of which is closely joined with its *vis-à-vis* to form a pair directly above the united first adambulacral plates, and by having, instead of two gonads to a ray, a considerable series along either side of each ray. Unfortunately none of these points except the first is brought out in Perrier's figures or mentioned in the description, since such details have generally been omitted as of no particular importance. In part they furnish a key for a natural generic analysis.

Through the courtesy of Dr. H. L. Clark, of the Museum of Comparative Zoology, I recently examined an authentic example of *Freyella spinosa* received from the Muséum d'Histoire Naturelle. It belongs to the group which I called *Freyellidea*. This specimen, no. 1447, has two gonads to each ray, each gonad consisting of a good-sized clump of tubules with a single aperture to the exterior. There is no syzygy between the first and second adambulacral plates; no syzygial joint between the upper end of the second and third ambulacral ossicles, although the interval is very narrow; there are no supero-marginals directly above the first adambulacrals. The first and second, and in one interbrachium also the third, adambulacral plates are joined to the corresponding adjacent plates of the next ray, although not so closely as in the other generic group, there being considerable tissue between the supposed plates. It was this feature, figured by Perrier, which led me to suppose that *F. spinosa* belonged with the group containing *F. fecunda*, *F. spatulifera*, and others, in which the first adambulacrals are always tightly joined. For the present it is best to consider this character

* Ann. & Mag. Nat. Hist. (8) xx. p. 418.

as of secondary importance in true *Freyella*, which is really not very closely related to the genus containing *F. fecunda*. The latter is distinguished by a syzygy, well-developed marginals for the interbrachium, and serial gonads.

For the genus, which I called *Freyella*, I propose the name *Freyellaster*, with *Freyellaster fecundus* (Fisher) as type. In this group belong *Freyellaster spatulifer* (Fisher), Macassar Strait, 901 fathoms; *Freyellaster scalaris* (A. H. Clark), Galapagos Islands, 812 fathoms; and probably also *Freyella polycnema*, Perrier.

The group which I termed *Freyellidea* will therefore become *Freyella*, with *Freyella spinosa* as type, and *Freyellidea* will drop out as a synonym.

The Genus Hymenodiscus, *Perrier.*—In the paper on the Brisingidæ above referred to, this genus was not placed in the synoptical key owing to lack of data. I have since

Fig. 1. Fig. 2.

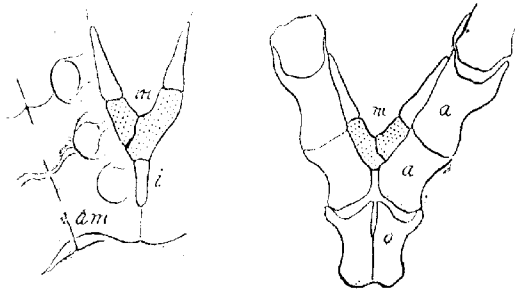

Fig. 1.—*Hymenodiscus agassizi.* An interbrachium from above first marginal plates, dotted.

Fig. 2.—*Hymenodiscus agassizi.* An interbrachium from actinal side. *a*, adambulacral plates; *am*, ambulacral plates; *i*, interradial; *m*, marginals; *o*, mouth-plates.

examined Perrier's type in the Museum of Comparative Zoology (no. 1448) *. The type of *Hymenodiscus agassizi* is almost certainly a very immature specimen, as it is small, and there are no gonads. There are no skeletal arches on the rays and the greater part of the thin abactinal integument

* For description see Perrier, 1884, 'Mémoire sur les étoiles de mer recueillies dans la mer des Antilles,' p. 189, pls. i. & ii.

has been removed. The fine spinulation of the disk extends upon the base of the ray. The abactinal integument of the ray, although very delicate, contains a single layer of lattice-work holothuroid plates, some of which at the very base of the ray bear minute spinelets. From this it would seem that the abactinal wall of the ray is destined to be similar to that of *Freyella*, unless in the fully adult animals the plates retain their embryonic character.

The interbrachium resembles that of *Brisingella*, but differs in having the first marginals (those which bound the apex of the interbrachial angle) unequal in size, as shown in the accompanying figures (figs. 1 and 2). In *Brisingella* these plates are equal, and the suture between the interradial ends is on a line with the interradial, or median oral, suture. There is a distinct syzygy between the first and second adambulacral plates. The interbrachia are not so open as in *Brisingella*, as the inner ends of the first adambulacral plates are normally in contact, or very nearly so. In an adult specimen we would expect to find these plates still closer together. It is worth noting that in *Freyellaster* and in *Brisinga*, s. s., the first marginal plates are of unequal size (see figs. 1 and 2, *m*, of "New Genera and Species of Brisingidæ"). Yet in its present juvenile form the interbrachial angle is different from that of either *Freyellaster* or *Brisinga*, while the entire absence of costal arches, as well as of gonads, may reasonably be attributed to immaturity. It does not seem possible to identify this problematical form with any other genus, except the even less known *Gymnobrisinga* of Studer.

Gymnobrisinga sarsii (Abhandl. Akad. Wiss. Berlin, Anhang, Abth. 2, 1884, p. 13, pl. iii., fig. 5) is based upon a brisingoid ray only. This lacks a dorsal skeleton, and while the large pedicellaria figured by Studer is different from those of *Hymenodiscus agassizi*, I am quite unprepared to offer an opinion as to the generic distinctness of the two species.

The Relationships of Labidiaster.—Although *Labidiaster* is very generally considered to be a member of the Brisingidæ, I would suggest that it has few essential characters in common with that family. The genus to which it exhibits greatest structural similarity is *Coronaster* *, Perrier. *Coronaster*

* See Fisher, "The Asteroid Genus *Coronaster*, Perrier," Proc. Biol. Soc. Washington, vol. xxx. pp. 23-26, Feb. 21, 1917. *Coronaster* includes the following nominal species:—*C. parfaiti*, Perrier, type, *C. antonii*, Perrier, *C. briareus* (Verrill), *C. volselliatus* (Sladen), *C. octoradiatus* (Studer), *C. biepinosus*, Ives, *C. halicepus*, Fisher. I have examined

seems to be more nearly allied to *Pedicellaster* than to either *Heliaster* or to any of the recently proposed genera of Asteriidæ. I would therefore place *Labidiaster* in the Pedicellasteridæ. I have dissected a large example of *Labidiaster radiosus*, Lütken, from the Straits of Magellan.

Labidiaster differs from *Brisinga*, *Odinia*, *Freyella*, and similar genera in the following important particulars:—(1) Its abactinal skeleton is not duplicated in the Brisingidæ; (2) forficiform, or straight, pedicellariæ are present; (3) the adambulacral plates are crowded, very short in proportion to width, and entirely unlike in form and armature the same highly peculiar plates of all Brisingidæ; (4) the ambulacralia are shorter, especially the dorsal ends, which overlap, or imbricate with, the next adoral ambulacral plate, while in the Brisingidæ there is no sign of imbrication, the ambulacralia resembling the centra of chordate vertebræ, with vertical articulating adoral and aboral facets.

In the Brisingidæ (in the narrower sense) the abactinal skeleton of the rays is variable, being in the form of transverse, independent, parallel ridges or costæ, separated by areas of integument without plates; or the interyals may be partially or completely filled in with more or less imperfectly developed plates immersed in the body-wall; or the arches may be absent and a tessellation of thin plates may cover the genital region of the ray; or there may be thin plates, more or less spiniferous, together with differentiated transverse costæ.

In *Labidiaster* the skeleton of the ray is closely similar to

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volsellatus, *briareus*, and *halicepus*. *Coronaster* includes *Heterasterias*, Verrill, type *Asterias volsellata*, Sladen. In the above paper the following remarks occur:—"The family affiliations of *Coronaster* are not easy to determine, its lineage being somewhat involved. The tendency to crowding in the arrangement of pedicels partakes of the Asteriidæ, while its mouth-plates are quite as 'brisingoid' as those of *Odinia*, and perhaps more so than the oral angles of *Labidiaster*, two groups placed in the Brisingidæ. Its skeleton is more like that of a simplified *Pedicellaster* than like that of *Asterias* or allies. Parenthetically, the mouth-plates of *Pedicellaster* are more prominently 'adambulacral' than those of any genus of the Asteriidæ, even of *Cosmasterias*, and are nearly or quite as prominent, relatively, as the oral angles of *Brisinga*. In *Pedicellaster* and *Coronaster* the ambulacral plates are more 'brisingoid,' uncrowded, and the pedicel-pores are in two series, even if later the feet themselves lie in four ranks. In very large specimens of *Coronaster* the pedicel-pores form two slightly zigzag rows, much less pronounced than in *small* specimens of *Cosmasterias* (in the broader sense), and the ambulacralia are less crowded. My own feeling is that, until we arrive at a more satisfastory basis for the subdivision of the Asteriidæ than is now current, it will be much better to leave *Coronaster* in the Pedicellasteridæ."

that of *Coronaster*. There is a longitudinal series of trilobate infero-marginal plates, one of quadrilobate or cruciform supero-marginal plates, and one of cruciform median radial plates. The marginals and radials form regular transverse series. On the basal portion of the ray there is a more or less irregular zigzag series of trilobate dorso-lateral plates. The primary plates either connect directly by their slender lobes, or these are joined by one or two overlapping, oblong, intermediate ossicles. There results an open, fairly regular, reticulate skeleton having large tetragonal meshes (except where the dorso-lateral plates frame pentagonal openings). On the outer part of the ray the *longitudinal*, intermediate, connecting plates and the longitudinally oriented lobes of the marginals and radials gradually disappear, so that there remains only a series of independent, transverse, slender skeletal bands, simulating those of *Brisinga*, but having a very different history*. The skeletal meshes contain numerous papulæ. The form and armature of the adambulacral plates are as in *Coronaster*. The arrangement of the pedicellariæ either in retractile wreaths surrounding the spines or in retractile transverse cushions is not unlike that found in *Coronaster*†. The mouth-plates of the Brisingidæ, of *Coronaster*, *Pedicellaster*, and of *Labidiaster* are similar in general form, those of *Labidiaster* being relatively the smallest.

The features which are chiefly relied upon to distinguish the Brisingidæ, and to which the family in part owes its characteristic appearance, are conspicuous by their different form in *Labidiaster*. Such, in the Brisingidæ, are the elongate and peculiarly formed adambulacral plates; the long needle-like subambulacral and marginal spines, with their characteristic sacculate sheaths; the variable but always non-reticulate abactinal skeleton of the rays; the presence of only crossed or forcipiform pedicellariæ.

The genus *Rathbunaster* (type *Rathbunaster californicus*,

* Verrill, in his 'Monograph of the Shallow-water Starfishes of the North Pacific Coast,' 1914, p. 352, proposes a new genus, *Labidastrella*, for *Labidiaster annulatus*, Sladen. "It differs considerably in structure from *L. radiosus*, especially in having the dorsal and superomarginal plates nearly abortive distally, on the rays, beyond the genital regions." It is evident that this tendency to lose the dorsal skeleton of the distal part of the ray manifests itself in *L. radiosus*, and is carried further in *L. annulatus*. I agree with Kœhler that it does not form a safe basis for a generic division between two otherwise similar species (Kœhler, Ann. de l'institut océanographique, vol. vii., fasc. 8, May 1917, p. 8).

† See Sladen's figures of *Asterias* (= *Coronaster*) *volsellata*, 'Challenger' Asteroidea, pl. cvii.

from off California, deep water) was described by me as a neighbour of the curious polybrachiate *Pycnopodia* of Stimpson. I think the genus is related, instead, to *Coronaster*. It is notable for the suppression of the alternate superomarginal plates and the reduction of the abactinal skeleton to spaced circular plates without trace of connectives. The marginal and abactinal plates bear an acicular spine surrounded by a retractile sheath with an expanded distal crown covered with numerous pedicellariæ. The ambulacral, adambulacral, and oral plates are similar to those of *Coronaster*.

In *Labidiaster*, *Coronaster*, *Rathbunaster*, and certain genera of the Brisingidæ there are two gonads to each ray; each gonad opens upon the side of the ray at some distance from the base. All three genera, as well as the Brisingidæ, have a single ampulla to each tube-foot.

The family Pedicellasteridæ, if these views are correct, would consist of the subfamily Pedicellasterinæ with *Pedicellaster*, *Lytaster*, and *Gastraster*, and of the Labidiasterinæ with *Labidiaster*, *Coronaster*, and *Rathbunaster*.

Asterina coronata *and* Asterina cristata.—In the 'Archiv für Naturgeschichte,' vol. xxxii., 1866, p. 73, von Martens describes *Asterina coronata* from Batjan, Molucca Islands, and from Larentuka, Flores Island, and records its occurrence at Amboina. His description states that the relation of the minor to the major radius is as 1 to 2 or $2\frac{1}{3}$, that the abactinal plates are so arranged that the dorsal surface has a honeycombed appearance, the plates bearing five or more spinelets, and that scattered over the dorsal surface are groups of two to four heavy spinelets with a common base, such groups being found on the sides and radial regions of the ray, but not close to the border. On the disk these special spinelets outline an irregular pentagon.

In the 'Proceedings of the Biological Society of Washington,' vol. xxix., p. 27, Feb. 1916, I described *Asterina cristata* from the Caroline Islands, the special peculiarity of which is the presence of a variable number of abactinal plates (upward of fifty to a ray), elevated and tubercular in form, and surmounted by one to five unequal, robust, pointed spines, the largest being four or five times as long as the spinelets of the other plates, and many times greater in diameter. These elevated plates, with their tuft of enlarged spines, I take to be the same as von Martens's "Büschel von 2–4 starker Stacheln mit gemeinsamer Basis," which he says, "stehen auf den Armen ziemlich zerstreut, sowohl auf dem Rücken als an den Seiten, aber nie ganz nahe am Rande." The

the chief character of the two species is the same. As Dr. H. L. Clark has suggested in a letter, the two species are probably the same, although there exist certain discrepancies. Von Martens does not mention subambulacral spines, but states that the furrow-spines are "in einer Reihe, 4 oder 5 fast gleich Grosse auf jeder Platte," and that the actinal intermediate plates have two relatively long sharp spines. The type of *Asterina cristata* has two to four, mostly three, actinal intermediate spinelets, usually six furrow-spinelets webbed for about half their length, the three or four median conspicuously longer than the laterals, and usually four subambulacral spinelets, of which the two median are much longer than the laterals. I think it is possible that von Martens overlooked the small lateral furrow-spinelets, although not likely; but certainly in no specimens seen by me are the furrow-spinelets ever subequal.

The case is somewhat complicated by two specimens of a race of *coronata* which I saw some years ago in the British Museum. One was contained in a box with *Nepanthia maculata*, labelled "Migupou, 7 to 12 fathoms, fine sand and coral —Cuming." The other was labelled "Port Essington, Australia." In the first specimen there are twenty or twenty-five of the prominent plates to each fifth of the body. The actinal intermediate plates have, in the neighbourhood of the furrow, about five or six spines in a rude circle, one spine being longer than the others; near the ambitus there are three spinelets, with often one or two standing mesad from the principal comb. The furrow-spinelets are five or six, webbed, the laterals shorter than the mesial spinelets; the subambulacral spinelets are four or five, shorter and stouter than the furrow-spinelets, and also graduated in size, the mesial spinelets being longest*. I made no notes on the Australian specimen, but my impression is that it does not materially differ from the other.

Thus the actinal intermediate spinelets are more numerous than in the types of *coronata* and *cristata*, while the adambulacral armature is about the same as that of *cristata*. The prominent abactinal plates are fewer than in *cristata*, and more like the condition in Japanese specimens.

Dr. Seitaro Goto, in his work on Japanese Asteroidea, carefully figures and describes a species from the southern parts of Kyushu and adjacent islands which he calls *Asterina novæ-zelandiæ*, Perrier, but which I believe is a form of

* For the privilege of examining these and many other specimens of Asteroidea in the British Museum (Natural History) I am indebted to Professor F. Jeffrey Bell.

coronata, as it possesses the prominent abactinal plates so characteristic of *coronata*. Thus there are records from southern Japan to northern Australia.

As a beginning towards straightening the tangle of apparent races, I would suggest the subjoined scheme. Any further evidence for or against it, or in any way bearing upon the status of *Asterina coronata*, will be most welcome:—

a^1. Abactinal spiniform pedicellariæ present; 8 adambulacral furrow-spinelets; 8 or 9 marginal mouth-spinelets; 12 to 14 enlarged abactinal plates ..... *Asterina coronata enerces** (Fisher). (Palawan.)

a^2. No spiniform pedicellariæ present; furrow-spinelets 4 to 6; marginal mouth-spinelets 5 or 6.

b^1. Actinal intermediate spinelets usually more than 3; near the furrow 5 or 6, forming a circle or group (not a straight comb); furrow-spinelets 5 or 6; 20 to 25 prominent abactinal plates to each fifth of body ..... *Asterina coronata fascicularis*†, subsp. n. (Migupou; Port Essington?)

b^2. Actinal intermediate spinelets 2 or 3, but not often 4.

c^1. Furrow-spinelets 4 or 5; actinal intermediate spinelets usually 2; prominent abactinal plates moderate in number (up to 25 to each fifth of body) and with as many as 25 spinelets to a plate‡ ..... *Asterina coronata coronata*, von Martens. (Southern Japan, Batjan, Larentuka.)

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* Fisher, Proc. Biological Society of Washington, vol. xxx., May 23, 1917, p. 91. Ulugan Bay (near mouth of Baheli River), Palawan Island, Philippine Islands, 2 to 5 feet, mud, sand, sea-weeds.

† This new race is certainly different as regards the actinal intermediate armature. Von Martens states that there are two spinelets in *coronata*. Of course, specimens may prove to be variable.

M. Alvin Seale, of the Museum of Comparative Zoology, who has lived many years in the Philippine Islands, tells me he has sailed past a fairly well-known *Migupou Point*; but I have not been able to locate it, with available maps, on Mindanao or on Luzon. Mr. Seale does not recall upon which of the two islands the point is found. It is quite possible that this is the locality from which so many of Gray's types were derived.

‡ So far as true *coronata* is concerned, the remarks concerning the number of prominent plates and the number of spinelets on these plates are conjectural. These observations refer to the Japanese form, described and figured by Dr. S. Goto ('A Descriptive Monograph of Japanese Asteroidea,' 1914, p. 650, pl. xix., figs. 279-281), which may, of course, be quite distinct from typical *coronata* of the Moluccan region.

c. Furrow-spinelets 6; actinal intermediate spinelets usually 3 (2 to 4); prominent abactinal plates numerous (more than 30 and as many as 50 to each fifth of body) and with not more than 15 spinelets to a plate, frequently 10 or less ..... *Asterina coronata cristata* (Fisher)*. (Caroline Islands.)

EXPLANATION OF PLATE XIII.

Type of *Asterina coronata cristata* (Fisher).

VI.—*Is* Dicrocœlium lanceatum *a Parasite of the Cat? A Note on a new Variety.* By H. A. Baylis, B.A.

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[Plate XIV.]

References have occasionally been made in helminthological literature † to the occurrence of "*Distomum lanceolatum*" ‡ in the cat. These cases have, however, in recent years been generally discredited, and it has been suspected that the parasites recorded belonged to one or other of the species of *Opisthorchis* or *Clonorchis* (*O. felineus* and *C. sinensis*) known to occur in cats, these forms being more or less similar to *Dicrocœlium lanceatum* in size and superficial appearance, though differing widely from it in their internal structure.

The typical *D. lanceatum* is a well-known parasite of sheep and cattle, and of various other herbivorous mammals; it is also an occasional, and probably accidental, parasite of man, having been met with some six times. Its occurrence in a carnivore, however, is a point with regard to which some scepticism is not unnatural. When, therefore, I received some time ago some Trematodes taken from the liver of a cat, I was greatly interested to find that they belonged undoubtedly to the genus *Dicrocœlium*, and differed from the typical *D. lanceatum* only in certain very small anatomical

* This form is probably distributed over western Oceania. It seems to be readily separable from the Japanese form, which has been classed as true *coronata*, although it probably is not.

† See, *e. g.*, Leuckart, 'Die Parasiten des Menschen,' I., Abth. 2, p. 360; von Linstow, 'Compendium der Helminthologie,' p. 30.

‡ Synonymy: *Fasciola lanceolata* Rudolphi, 1803; *Distomum lanceolatum* Mehlis, 1825; *Dicrocœlium lanceolatum* Dujardin, 1845; *Dicrocœlium lanceatum* Stiles & Hassall, 1897.

details. These specimens, of which there is a considerable number, were collected at Georgetown, British Guiana, by Mr. G. E. Bodkin, Government Biologist, during November, 1915. They were kindly handed to me for determination by the Imperial Bureau of Entomology.

On a consideration of the many resemblances between these examples and the typical *D. lanceatum*, and of the minor points in which they differ from it, I am inclined to regard them as belonging to a well-marked variety of that species, rather than a distinct form. The one salient feature is the position of the testes, which in the specimens under consideration invariably lie symmetrically opposite to each other in the same transverse plane. All authorities are agreed in describing the testes of *D. lanceatum* as being placed nearly "tandem," *i.e.*, one behind the other, but somewhat diagonally, near the longitudinal axis of the body *. The exact position of the testes is, as a rule, a very constant specific character in Trematodes; but in this case the almost complete correspondence between the rest of the anatomy and that of the typical form seems to outweigh such a consideration. The only other differences that I have been able to find are in the somewhat smaller size of the cirrus-sac and the slightly larger average size of the eggs. Even the coils of the uterus show complete agreement, as far as they can be traced. For the sake of comparison, however, with the type, it may be worth while to give a fairly full description of the new variety.

The length of the worms varies between 5 and 7 mm., and the maximum widths for these lengths respectively are 1·62 mm. and 2 mm. The body is flattened dorso-ventrally, narrowing considerably from side to side in front, and less so behind. The posterior end is frequently somewhat rounded; sometimes, however, it is more pointed than in the example figured. To the naked eye the body is whitish and semi-transparent (in spirit), the masses of fully-formed eggs in the uterus being visible as blackish or brownish patches. The skin is smooth.

The oral sucker is subterminal, and has a diameter of

* Neveu-Lemaire ('Précis de Parasitologie humaine') gives a figure of *D. lanceatum* (reproduced in Brumpt's 'Précis de Parasitologie,' 2nd ed. 1913, p. 335), in which the testes are symmetrically arranged; but there is no reference to the source of the specimen from which the original figure was drawn, and no description of the internal anatomy is given in Neveu-Lemaire's work. The figure is, in other respects, very rough and inaccurate.

0·37 mm.*. The ventral sucker is situated 0·7 mm. behind it, and measures 0·4 mm. across. The mouth is followed immediately by a small, almost globular pharynx, measuring 0·15 mm. in length, and this is succeeded by an œsophagus 0·2 mm. long. The two simple intestinal diverticula extend backwards to within a little more than 1 mm. from the posterior end. They lie, for the greater part of their length, near the lateral margins of the body.

The excretory vesicle is small and inconspicuous. Its pore is terminal.

The genital pore is median, situated between the two suckers and at about the level of the bifurcation of the intestine. The testes are large compact bodies, slightly lobulated, especially on their lateral margins. They lie, as has been noted already, symmetrically opposite to each other, immediately behind and at the sides of the ventral sucker, and between the intestinal diverticula. Each testis measures about 0·8 mm. in length and 0·6 mm. in width. The ovary is a body of variable shape, but usually somewhat lobate; it is situated close behind the testes, but its position shows considerable variation. It appears to be rather more commonly situated on the right side than on the left, but in three out of eight stained examples the ovary was placed behind the left testis. There is a rather large rounded receptaculum seminis, situated just dorsally to the posterior edge of the ovary. Laurer's canal is present, and a shell-gland, not differing from that of the typical *D. lanceatum*. The cirrus-sac is about 0·4 mm. long and 0·15 mm. wide. It contains a coiled vesicula seminalis. The cirrus-sac participates in the variability of position shown by the ovary and its associated organs. Thus, when the ovary is on the right, the cirrus-sac lies to the right of the terminal portion of the uterus; when the ovary is on the left, the positions of the genital ducts are generally reversed.

The vitelline glands lie within the middle third of the body, and extend along the sides as a series of lobes of various sizes. The two vitelline ducts are given off somewhat in front of the middle of the glands, and cross the body to unite into a much wider single duct just behind the ovary.

The uterus fills almost the whole of the middle and posterior portions of the body, from the level of the anterior end of the vitelline glands to the tail. Its coils, for the most

* This and the following measurements are taken from an example 5 mm. long, and are therefore to be regarded as somewhat below the mean.

part, take the form of transverse folds and lateral loops. In the middle region these are confined to the space between the vitelline glands, but more posteriorly they sometimes extend laterally beyond the intestinal diverticula. The ascending limb of the uterus passes forward between, and ventrally to, the testes. The eggs are roundish-oval in shape, and when fully formed have a rather thick brown shell, usually showing an indentation on one side, so that in profile one side is convex, the other concave. The eggs measure 42·5–50 $\mu \times 30$–35 μ.

The variety described above I propose to call

Dicrocœlium lanceatum St. & Hass., var. *symmetricum*,

in allusion to the arrangement of the testes.

This variety being at present known only from specimens collected from a single host, a cat, it is doubtful whether it should be regarded as a "local" variety or as a form peculiar to cats. An examination of examples of *D. lanceatum* from sheep or other herbivorous animals in the same locality would be of great interest from this point of view, as well as a further investigation of the parasites of cats. In any case, it would appear that the older helminthologists may have been correct in reckoning the cat among the hosts of "*Distomum lanceolatum*."

EXPLANATION OF PLATE XIV.

Dicrocœlium lanceatum, var. *symmetricum*. Ventral view of a stained specimen. *C.S.*, cirrus-sac; *Int.*, intestinal diverticulum; *Ov.*, ovary; *R.*, receptaculum seminis; *T.*, left testis; *V.*, vitelline glands; *V.S.*, ventral sucker.

VII. — *The Eggs and Spawning-habits of the Pilot Fish* (Naucrates ductor). By J. D. F. Gilchrist, M.A., D.Sc., Ph.D.

In the course of a general enquiry into the spawning-habits of Cape fishes, a mature female of the pilot fish was found. The eggs and larvæ of about thirty Cape fishes have been described in local publications, but, as the pilot and its peculiar habits are so well known, and have attracted attention in all parts of the world, a description of the mature eggs of this fish, hitherto unrecorded, may be worthy of a special note, and interest a wider circle of readers, more especially as the nature of the eggs seems to

throw light on some peculiarities in the behaviour of the fish.

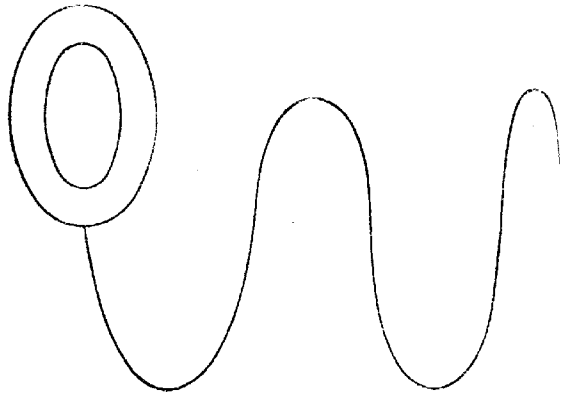
The pilot fish is not uncommon in the Cape seas. The young are frequently abundant in the summer months, being found in company with the young of *Lichia amia*, which they somewhat resemble in the characteristic markings of the body. The adults are well known, under the name "Lootsman," to Cape fishermen, who state that they are always found accompanying a large shark, called the "Tor-nijn Haai" or porpoise-shark (*Charcharias melanopterus*). They take up a more or less constant position near the body of the shark, and remain within a few inches of the base of the pectoral fin. The fishermen have also noted that they have the habit of darting away from the shark towards any strange object, and then returning to their former position. This well-known behaviour, interpreted in other parts of the world as a guiding or piloting of the shark to its food, the Cape fishermen believe, is for the purpose of a preliminary tasting or testing of the food on behalf of the shark.

On one occasion, in the month of December, a specially large pilot fish was caught on the hook by some fishermen fishing off Cape Point. It was in the company of a porpoise-shark. By placing the fish in a bucket of water, it was possible to keep it alive, and convey it to the Marine Laboratory at St. James, where it was placed in a large tank, and seemed none the worse for its capture. It proved to be a mature female with ripe eggs, which were extruded on slight pressure.

These extruded eggs were readily seen, being large, though quite transparent. When placed in water, however, they became almost invisible. They did not float, and they adhered to each other and to objects with which they came in contact. The shape of the eggs was distinctly oval, though a few were more rounded. A typical example, shown in the accompanying figure (p. 116), measured 1·74 mm. in length and 1·3 mm. in greatest breadth. In another case the measurements were 1·65 × 1·39 mm. There were very minute dots on the surface of the egg, and from one pole originated a single fine filament. This was of considerable length, being in one case six times the length of the egg, or about 10 mm. In most cases it was shorter, and in some it appeared to have broken off close to the egg. The filaments readily became entangled with each other, so that it was difficult to separate out any particular one without breaking it. At its base the filament had a broad attachment to the outer membrane, of which it is apparently

a modification. At this point it was about ·04 mm. in diameter, but soon diminished to about ·016 mm. The filament appears to be homogeneous throughout, but, if treated with hot caustic potash, it has the appearance of a thick-walled tube.

At the distal pole of the egg, opposite that from which the filament arises, there is a marked differentiation of the surface of the egg, on a small terminal area about ·2 mm. in diameter. This area is covered with clear polygonal markings, which vary in size, being large towards the periphery, where they fade off into the surrounding surface. Near the centre they become smaller and less distinct, and



Egg and filament of *Nauerates ductor*.

pass into a small thickened ring, in the centre of which the micropyle may be clearly seen.

There is a large perivitelline space, about a fourth of the diameter of the whole egg in breadth at the middle of the egg. In the specimen figured this breadth was ·32 mm.

The egg proper or yolk is an ovoid mass, somewhat more oblong in shape than the outer shell of the egg. It is clear, but granular, and no traces of vesiculations nor oil-globules were seen. In preserved material several cases were observed in which the yolk had shrunk away from its surrounding perivitelline substance, and, in such cases, at the distal end opposite the micropyle, a small funnel-like

projection appeared, which in the normal condition would penetrate the yolk-mass to a slight extent. It doubtless has some function in the mechanism of fertilisation, though no canal connecting it with the microphyle was detected in the perivitelline substance.

The mode of origin of the filament of the egg is different from what is found in some other filamentous eggs of Teleosts. Thus, in the egg of the South African species of *Hemirhamphus* and *Atherina*, I have noticed that, in the immature and even fairly small ovarian eggs, the filaments occur as irregular streaks on the surface of the zona radiata, but, in those of *Naucrates*, the filament is already free, and serves to attach the egg to the wall of the ovary. A number of such filaments are inserted at one spot, so that the ovarian eggs are often grouped in grape-like clusters, or the filaments become twisted on each other to form a rope-like structure, round which the eggs are grouped.

The presence of filaments on fish-eggs, as a rule, has been found to be associated with the fact that they are anchored to each other or to foreign objects, floating or lying at the bottom of the sea. Thus the eggs of *Hemirhamphus*, *Belone*, and *Exocœtus* have been found attached to each other and to sea-weed in this way, though *Scombresox*, another member of the same family, is said to have pelagic eggs provided with filaments. Another family, the Atherinidæ, all the members of which have eggs provided with filaments, so far as is known, have demersal attached eggs.

There is thus a reasonable presumption that the possession of filaments indicates that the eggs are, ultimately at least, attached to some object fixed or floating in the sea, and, if we suppose that the filamentous eggs of the pilot fish are attached to the shark, with which the fish is so intimately associated, it may explain some peculiarities in its habits which have received a variety of explanations. These are not entirely convincing, partly on account of this variety, but chiefly on account of conflicting facts or of lack of confirmation.

Thus the explanation that the pilot feeds on the fragments of the food of the shark is not in accordance with the fact that small fish have been found in its stomach. The same objection applies to another conjecture that it feeds on the excrements of the shark, and still another that it feeds on the parasites on the skin of the shark. An explanation of a different nature, that the pilot keeps close to the larger fish for the purpose of protection from its enemies, is a more plausible one, but is somewhat strained when its very close

proximity is explained as a precaution against the attack of the shark itself. It is not in accordance with the supposed amicable arrangement whereby the pilot is allowed to have a share of food or excrement, in return for its piloting services. According to actual observation, the shark is not at all disconcerted by the absence of the pilot, but the pilot is said to be greatly agitated by the loss of the shark. It has even been observed "clinging to the side of a shark," and, on one occasion, it is stated that it was seen to leap out of the water in an endeavour to follow a shark which had been caught by hook and was being hauled on board a ship.

Another peculiarity in the behaviour of the fish, which seems to be of some significance in this enquiry, is the well-known fact that it sometimes accompanies large sailing-ships, which it follows so persistently that it is drawn far away from its natural habitat. It even follows the ship into the harbour, where it is easily caught.

Most of these peculiarities would be sufficiently explained if we suppose the pilot's eggs to be attached to the rough skin of the shark, or to the bottom of the ship, which is so persistently followed. We may recall in this connection the solicitude of such fishes as the Blennies for the safety of their eggs, how they keep close guard over them, driving off any approaching intruder. The close proximity of the pilot to the shark, the darting forward towards any strange object (which seems to be an undoubted fact), the persistence in following the shark or the ship in circumstances which are unfavourable to its own welfare, would seem to indicate a very powerful motive, not dissimilar to that of the fishes which guard their eggs.

The fact that the young stages of *Naucrates* are frequently got, but that no pelagic eggs such as those above described have, so far as I can ascertain, been procured in tow-nets, seems to have some further significance in this enquiry and to indicate that the eggs of *Naucrates* are not floating.

The only sufficient proof of the suggestion here offered would, of course, be the finding of such eggs attached to the body of a large shark or ship, which had been accompanied by a pilot fish, and it may be that, with the above-mentioned facts in view, the opportunity may arise for the solution of the long-standing mystery of the pilot fish.

VIII.—*Notes upon the Sika-Deer of North China.*

By Arthur de Carle Sowerby, F.Z.S., F.R.G.S.

The opportunity has recently been afforded me of examining a fully adult Sika stag, shot by Mr. J. Holmberg, of Tientsin, in the Fen-chou Fu district of West Shansi, during December 1916.

Previous to this, I believe, no complete specimen of this animal has ever been secured by a European; while, as far as I know, the only reference to it in any publication is that by Père Heude in his 'Mémoires concernant l'Histoire Naturelle de l'Empire Chinois' (tome iv. p. 210, pl. xxxvii. fig. 13), wherein he names the species *Cervus grassianus*, from a single pair of antlers from Tching-lo-hsien (Tsing-lo Hsien), Shansi. In a paper written by me on Père Heude's collection of pigs, sika, serows, and gorals in the Sikawei Museum, Shanghai, and published in the 'Proceedings of the Zoological Society of London,' April 1917, pp. 7–26, I suggested that the Shansi sika should be classed for the time being with Milne-Edwards's *Cervus mandarinus*, though I stated then that winter skins that I had seen were lighter in colour than the figure given by Milne-Edwards.

The stag which Mr. Holmberg so kindly allowed me to examine is, however, fully as dark as Milne-Edwards's winter figure, though in this connection it is interesting to note that Mr. Holmberg states that the hinds and young that he saw with the stag were very much lighter. This agrees with my own observations. I have had no opportunity of determining whether or not the hinds and young of the Chihli sika are lighter than the stags; but as a result of my examination of Mr. Holmberg's specimen I do not hesitate to confirm Père Heude's separation of the Shansi sika from the other Chinese forms, and, although he gave no description, the fact that he gives a figure of a pair of antlers from Tsing-lo Hsien, West Shansi, makes his name hold good. Following is a diagnosis and description of the species:—

Cervus grassianus, Heude.

Cervus grassianus Heude, 'Mémoires concernant l'Histoire Naturelle de l'Empire Chinois,' tome iv. p. 210, pl. xxxvii. fig. 13.

A single fully adult male in winter pelage examined, also two winter skins of fully adult females, and a summer skin of a male, as well as two fully developed pairs of antlers, all from West Shansi.

♂ complete, from mountains 100 miles S.W. of Fen-chou Fu, Shansi, N. China.

Measurements in the flesh:—Head and body 60″, height at shoulders 42″, tail 8″, hind foot 16½″, ear 7″. Weight 165 catties=220 lbs. (about).

Colour. A general greyish brown on the head, going into brown on the forehead and a pale buff at the base of the horns and the base and backs of the ears, the inside of the ears being white. Nose dark brown; chin dark brown, almost black, with a small white patch on either side. Area round the eye buffy-grey. The general colour gets darker on the neck, but it still retains a wash of buff or ochre. The body is dark greyish brown, with a slight indication of a darker median dorsal line. The spots are almost invisible, showing up in certain lights and quite invisible in others. The dark greyish brown of the body shades into a rich brown on the back and lower portions of the legs, getting lighter and more ochraceous on the fetlocks. There is a peculiar patch of long white hairs surrounded by black on the outer surface of the hind leg about 6 inches below the heel. The tail is black above, white beneath, the hairs being long and making the tail somewhat bushy. The croup disk is white, edged with black on its upper half, the black joining up with that of the upper tail surface, so that there is no white between the tail and the back. The under surface of the belly and inner surface of thighs are white; the chest is a dark brownish grey.

The hairs of the neck are considerably longer than on the rest of the body.

Horns. The horns in this specimen are not very well developed, being past their prime. They measure:—

Right, 19½″ in length.

Left, 19¾″ „

Right, above the brow-tine 3⅝″ in circumference, below 5⅞″.

Eight points, 4+4.

Other horns examined are large, graceful, and heavy, but not so large as is usual in *C. mandarinus*.

Skull. Condylo-basal length 322 mm.; zygomatic width 136 mm.; interorbital space 100 mm.; length of nasals 125 mm.; greatest width of palate (at post-molar) 54 mm.; greatest width of cranium 84 mm.; length of upper tooth-row 99 mm.; length of lower tooth-row 103 mm. Teeth well worn.

Type. A pair of antlers in the Sikawei Museum, Shanghai, no number, from Tching-lo-hsien (Tsing-lo Hsiên), Shansi.

The habitat of this species may be considered as confined to the forested and mountainous areas of that part of Shansi

that lies west of the Fen Ho. Even here it occurs only in a few isolated districts, namely:—

1. The forest to the south of Ning-wu Fu, west of Tsing-lo Hsien and north of Ko-lan Chou, where Heude's specimen was doubtless secured.

2. In the forested area 90 miles west of Tai-yuan Fu, known as the Chiao-ch'êng Shan.

3. In the forested area 100 miles south-west of Fen-chou Fu, known as the Ning-hsiang Hsien mountains.

Formerly its range extended throughout the whole of the mountainous area of West Shansi, as well as in the mountains that extend in a north and south line between Shansi and Chihli; but it has been almost exterminated by native hunters for the sake of its horns, which are highly valued as medicine. Only a few isolated herds occur in the districts above mentioned, where they keep to the densest parts of the forest. Even so, they are being steadily exterminated.

This sika ruts in November and December, sheds its horns about March, the new growth commencing about the end of July. It is during August and September that this species is most sedulously hunted by the natives, for then the horns are considered to be in their prime.

Following is a diagnosis of the sika occurring in the Chihli forests:—

Cervus mandarinus, Milne-Edwards.

Cervus mandarinus Milne-Edwards, 'Recherches pour servir à l'Histoire Naturelle de Mammifères,' vol. i. (text), pp. 184–186, vol. ii. pls. xxii. et xxii.A.

This sika differs from *C. mantchuricus*, Sw., in having the white spots larger and fewer in number, in being generally lighter in colour, with less white on the croup disk, and in having the parts below the belly the same colour as the flanks, instead of white. The differences in the winter pelage are not so marked.

Milne-Edwards states that the spots in *C. mantchuricus* in the winter pelage are so invisible as not to have been given in Sclater's figures. (In this it resembles the Shansi stag.)

In *C. mandarinus*, in spite of the general darkening of the pelage, the spots remain plainly visible.

In a letter published in the P. Z. S. 1865, No. 1, p. 142, Swinhoe retains the name *mantchuricus* for the Manchurian sika, having examined a living specimen at New-chwang in South Manchuria. He makes the statement that he suspects it to be the same as the deer, skins of which he secured in the Summer Palace, and which Blyth called *mantchuricus*

(P. Z. S. 1864, p. 109), but which Swinhoe himself subsequently called *hortulorum* (P. Z. S. 1865, p. 1).

As there is no telling where the deer confined in the Summer Palace came from originally, it being just as likely that they were brought from Manchuria as from the Imperial Hunting Grounds, owing to the fact that part of the tribute annually paid to the Imperial Manchu household from Manchuria consisted of game of various kinds, and since Milne-Edwards finds the Chihli species so distinct from the Manchurian form, it seems more than likely that Swinhoe's surmise as regards the common identity of his skins from the Summer Palace and his New-chwang specimen was correct; in which case his name *hortulorum* applying to the Manchurian sika is later than his name *mantchuricus*, and so becomes a synonym, thus leaving Milne-Edwards's name *mandarinus* clear for the Chihli specimen.

This species occurs in a wild state only in the Imperial Hunting Grounds, north of the famous Tung Ling (Eastern Tombs), and in the Wei-ch'ang to the north of Jehol, both in Chihli province, to the north and north-east of Peking. It occurs in a semi-domesticated state in the magnificent park at Jehol.

Up to recent times this deer has been strictly preserved, but in 1911–12 the Manchu soldiers that were sent out of Peking and were camped in the Eastern Tombs and Imperial Hunting Grounds were allowed to kill as many as they liked, while since that date native hunters have been allowed to hunt in these districts, with the result that in the wild state the species is practically extinct.

It may here be stated that unless immediate and very stringent steps are taken for their protection, both *C. grassianus* and *C. mandarinus* will become extinct, and the sika no longer remain on the list of North China mammals.

IX.—*Descriptions of new Genera and a new Subspecies of South American Birds.* By Charles Chubb, F.Z.S., M.B.O.U.

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Pseudoconopophaga, gen. nov.

The proposed new genus, which is based on *Conopophaga melanogaster*, Menetr., is distinguished from *Conopophaga*, founded on *Turdus auritus*, Gmel., by its long and narrow bill, the long tarsi and toes, the larger size, and different coloration.

Type, *P. melanogaster* (Menetr.).

MACKENZIÆNA, gen. nov.

Reichenbach, in 1850, proposed the generic name *Nisius*, and gave a figure in his Av. Syst. Nat. Vög. pl. lxxi., which has been associated by previous authors with *Thamnophilus leachi*, Such, as the type; but, when that bird is compared with the figure, it will be easily seen that Reichenbach could not have founded it on that species, as it is not anything like it. The species was originally, and has for many years been, placed in the genus *Thamnophilus*, Vieillot, where it was equally out of place, as it is so entirely different from that genus, which was founded on *Lanius doliatus*, Linn. I propose, therefore, the new generic title *Mackenziæna*, with the following characters:—Head not crested, no concealed white dorsal patch, tail much longer than the wing. Bill short and stout, the depth about two-thirds the length of the exposed culmen. The wing, which is rounded, has the fifth primary longest. The tail is also rounded and much graduated, the two middle feathers longest. Coloration: the male is black, with ovate white spots and bars to the feathers, and the female is brown marked with buff.

Type, *M. leachi* (Such).

FREDERICKENA, gen. nov.

The species which I propose to separate as a new genus under the above title has also been previously placed in the genus *Thamnophilus*, Vieillot, with which it has no near affinity; it may be characterized by the absence of a concealed white dorsal patch. The nuchal crest is composed of rather broad feathers with rounded tips. The bill is short and stout, the depth being equal to about one-half the length of the exposed culmen. The wing is rounded, the fourth, fifth, and sixth primaries longest and subequal; the seventh is longer than the third, but shorter than the fourth. The tail, which is rounded and graduated, is about two-thirds the length of the wing. The male is almost uniform in colour, but the female has the tail and entire under surface barred.

Type, *Thamnophilus viridis*, Vieillot.

PICROTES, nom. nov., pro *Lochites*, Cab. & Hein. 1859 (nec Gistel, 1848).

Type, *Lanius severus*, Licht.

SAKESPHORUS, nom. nov., pro *Hypolophus*, Cab. & Hein. 1859 (nec Müller & Henle, 1837).

Type, *Lanius canadensis*, Linn.

POLIOLÆMA, gen. nov.

This form is readily distinguished in having the throat uniform with the rest of the under surface. The bill, which is long compared with the other genera of this group, has the exposed culmen about equal in length to the hind toe and claw. The wing is rounded, the third, fourth, and fifth quills longest, the second about equal to the seventh. The tail is short and nearly square, the outer feather on each side is only very slightly shorter than the rest. The feet are small and weak. The male and female are entirely different in colour. I propose, therefore, that this form be separated generically under the name of *Poliolæma*.

Type, *Myrmotherula cinereiventris*, Sclater & Salvin.

DICHROPOGON, gen. nov.

The species which I propose to separate generically have hitherto been associated with *Hypocnemis* of Cabanis, but it differs altogether in colour as well as in its proportionate measurements. The bill is small and narrow. The wing, which is slightly pointed, has the third, fourth, fifth, and sixth primaries longest, the second about equal to the eighth. The tail, which is nearly square at the tip, is about two-thirds the length of the wing. The legs and feet are proportionately strong, the tarsus exceeds the length of the exposed culmen by about two-fifths. Male and female quite different in colour of plumage.

This genus is based on *Hypocnemis pœcilonota*, Cabanis.

Rhopias fulviventris salmoni, subsp. n.

Adult male. Differs from the adult male of *R. f. fulviventris* (Lawr.) in being uniform olive on the top of the head, back, and sides of face, instead of greyish brown; upper wing-coverts pale brown, not blackish; tail paler; the white on the throat more extensive; breast buff instead of slate-grey; abdomen and under tail-coverts paler and inclining to buff; under surface of quills pale brown, not blackish brown.

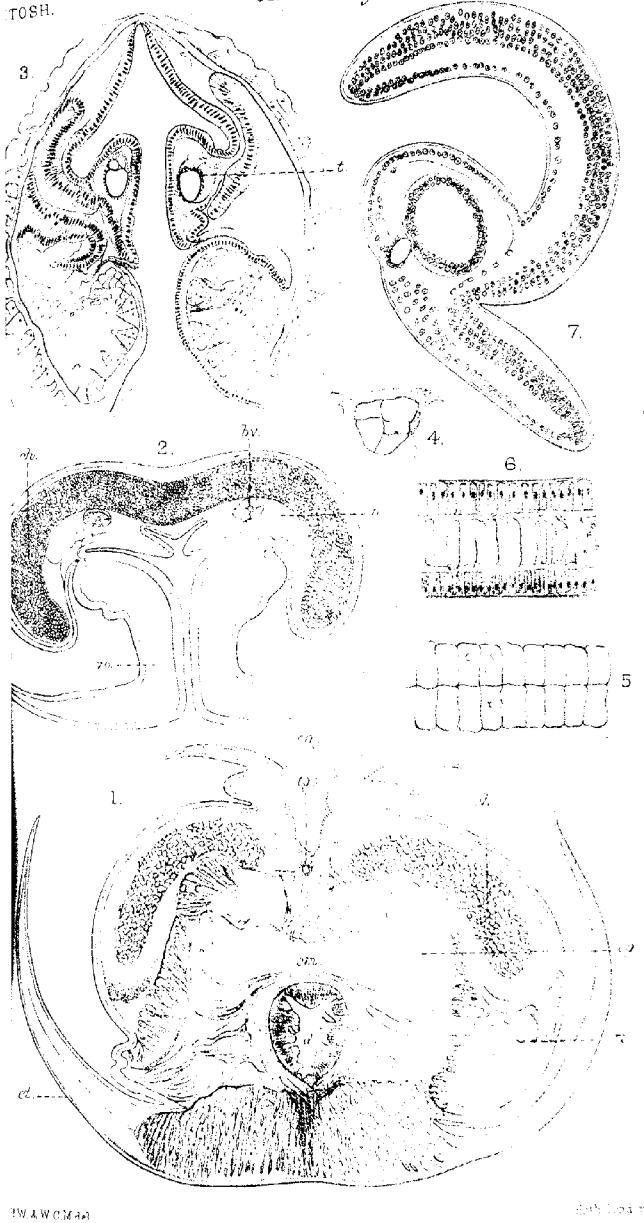
Total length 110 mm.; exposed culmen 12; wing 50; tail 37; tarsus 17.

Adult female. Differs from the adult female of *R. f. fulviventris* in being paler both on the upper and under surface. Wing 50 mm.

Hab. Colombia and Ecuador.

The type, which is in the British Museum, was collected by T. K. Salmon at Remedios, Northern Colombia.

TOSH.



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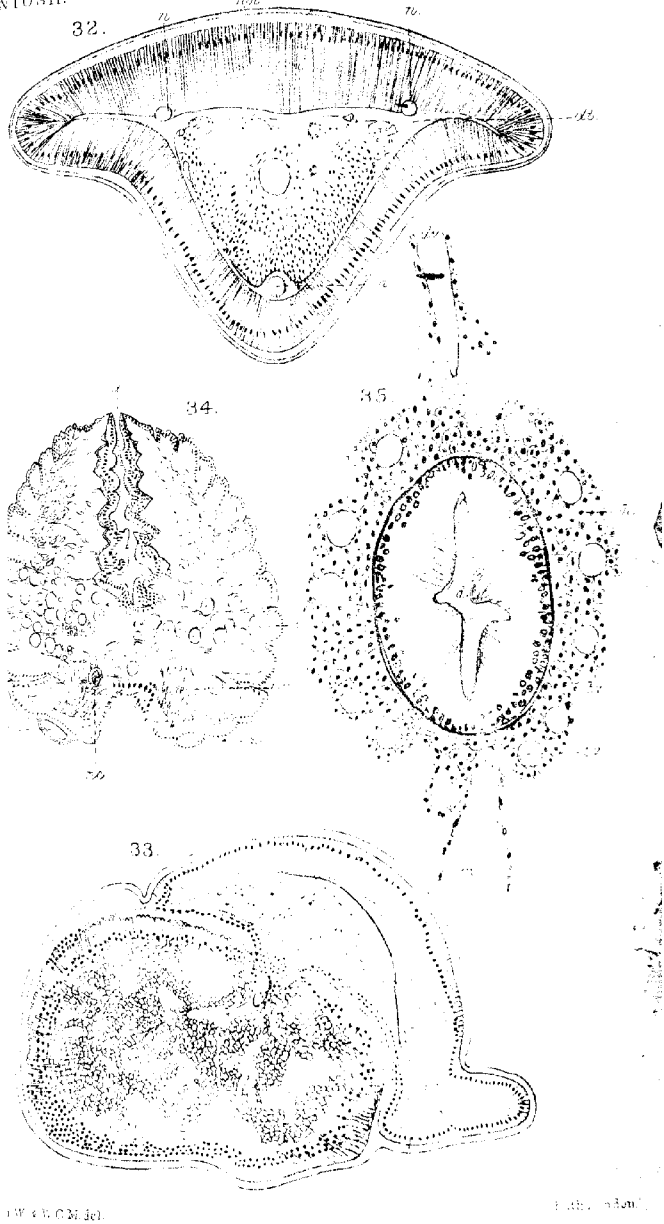
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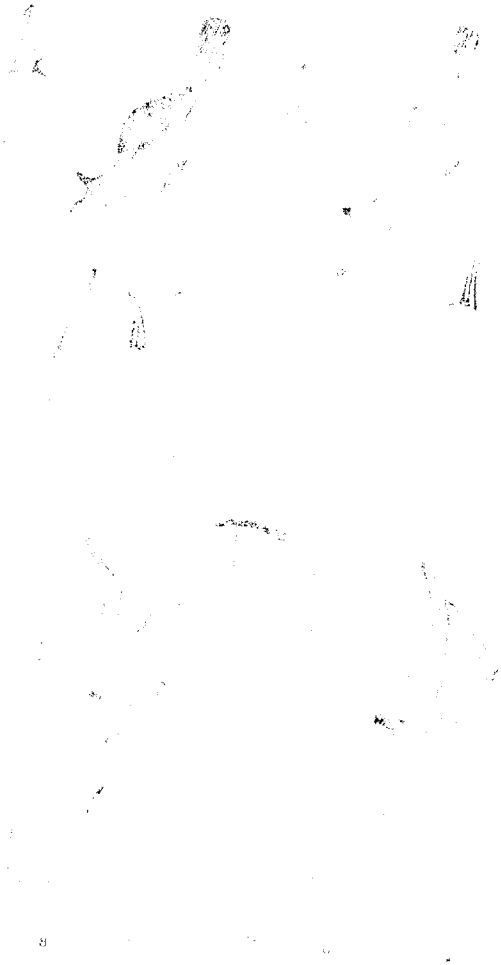

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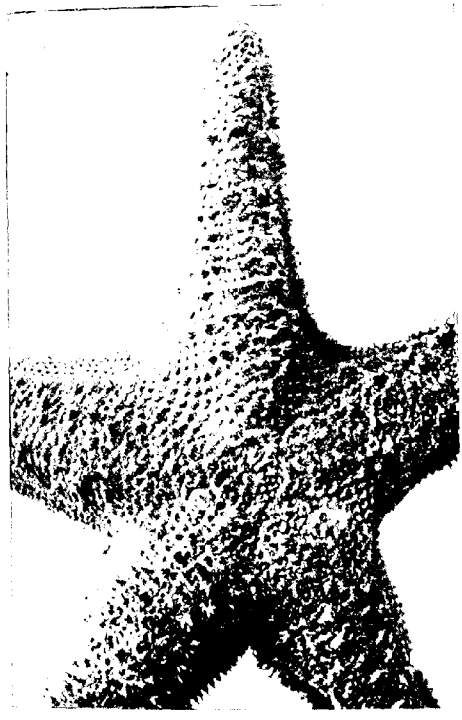

Type of Asterina coronata cristata Fisher

Pterocerium lanceatum, var. symmetricum